TM 10-1692A

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

CRANE, WAREHOUSE

MOBILE, SLUING, GASOLINE 10,000-POUND CAPACITY

HUGHES-KEENAN V–10 AND V–10 (RS)

DEPARTMENT OF THE ARMY • OCTOBER 1953

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TECHNICAL MANUAL
No. 10–1692A

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CRANE, WAREHOUSE, MOBILE, SLUING, GASOLINE, 10,000-POUND CAPACITY, HUGHES-KEENAN V–10 AND V–10 (RS)

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CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

This manual is published for the information and guidance of personnel responsible for the operation, maintenance, and repair of the Crane, Warehouse, Gasoline, Mobile, 180° Sluing Boom, 10,000-Pound Capacity, Hughes-Keenan V–10 (Quartermaster Stock Number 66–C–1708–100) and the Crane, Warehouse, Gasoline, Mobile, 180° Sluing Boom, 10,000-Pound Capacity, Hughes-Keenan V–10 (RS) (Quartermaster Stock Number 66–C–1708–110). Military Specification Number MIL–T–15451 applies to both models.

2. Identification

The instructions contained herein are applicable to the standard crane, Model V–10, and the radio-suppressed crane, Model V–10 (RS) procured under Contract Number N–600–S38–12047 as stamped on the crane name plate. The serial number, contract number, and model number should always be used in conjunction with Department of the Army Supply Manual QM 7 & 8 MHE 137 for the requisitioning of replacement parts.

3. Orientation

When used in this manual the terms "right," "left," "front," and "rear" indicate positions from the viewpoint of the operator sitting in the seat.

Section II. DESCRIPTION AND DATA

4. Description

The Hughes-Keenan V–10 crane (figs. 1 and 2) is a gasoline-powered, front-wheel drive, rear-wheel steer, materials handling vehicle. It is equipped with pneumatic tires for both indoor and outdoor operation and is capable of lifting, swinging, transporting, and lowering loads up to 10,000 pounds. Principal components of the crane are as follows:

a. Engine. Power is supplied by a six-cylinder, in-line, L-head, liquid-cooled gasoline engine. This engine has a brake horsepower of 85 pound-feet and a rated horsepower of 26.14 pound-feet at the governed speed of 2,800 revolutions per minute. The compression ratio is 6.8 to 1. The displacement is 226 cubic inches.

b. Clutches.

(1) *Engine.* The engine clutch is a spring-loaded, foot-operated, dry-disk type. It is part of the power train and serves to engage and disengage the engine and the transmission.

(2) *Boom topping and load hoist winch.* The boom topping and load hoist winches are each controlled by two compensating 8-inch friction-cone clutches. The clutches are engaged individually by the forward or backward movement of respective hand-operated shifter levers in the operator's compartment.

(3) *Sluing mechanism.* The sluing mechanism is provided with two 5-inch, friction-cone, compensating clutches, which are keyed to opposite ends of the sluing input shaft to swing the boom to the left or right. The sluing mechanism is also equipped with a third 5-inch, friction-cone clutch, which acts as a braking device to hold the turntable in a fixed position whenever the boom has swung more than 90° in either direction.

c. Transmissions.

(1) *Power train.* The power train includes two transmissions: the four-speed forward transmission and the reversing

transmission. These transmissions are housed in separate cases but are joined and driven by a common shaft. Control of the power train transmissions is effected through two gear shift levers in the operator's compartment. One lever selects the direction of travel and the other selects gear positions for speed of travel. Speeds for corresponding gear positions in forward or reverse are identical so that the crane can be driven in four speeds forward and four speeds reverse.

(2) *Boom topping and load hoist.* The boom topping and load hoist transmissions are identical in construction and consist of a single shaft with two keyed-on bevel gears that mesh with a third bevel gear to rotate winch drums. The boom topping transmission controls the winch drum that raises and lowers the boom. The load hoist transmission controls the winch drum that raises or lowers the load line to which the load block is attached.

(3) *Sluing.* The sluing transmission consists of a drive shaft and two bevel gears that mesh with a third bevel gear to slue the turntable and the boom to the right or left.

d. Differential and Drive Axle and Wheels.

(1) *Differential.* The differential is contained in a separate case mounted to the front of the crane by special angle mounting members. Gears are of the single-reduction type, with spiral bevel drive pinions and matching ring gears. Power from the transmission is transferred to the differential through a universal joint.

(2) *Drive axle.* The drive axle assembly consists of two shafts splined into differential side gears. Pinions on the outer ends of the shafts mesh with internal ring gears on the drive wheels. The shafts are also splined for the mounting of brake drums between the differential housing and the crane frame.

(3) *Drive wheels.* The drive wheels are of solid cast construction and are equipped with pneumatic tires mounted on demountable rims. They are mounted on dead axles and rotate on adjustable tapered roller bearings.

e. Steering System.

(1) *Steering gear.* The steering gear consists of the bevel gear case, located at the base of the steering column; the worm and worm sector case, located above the vertical spindle of the steering axle; and the universal joints, intermediate shaft, and stub shafts that connect the two cases. This arrangement provides the truck with a center-pivoted steering system.

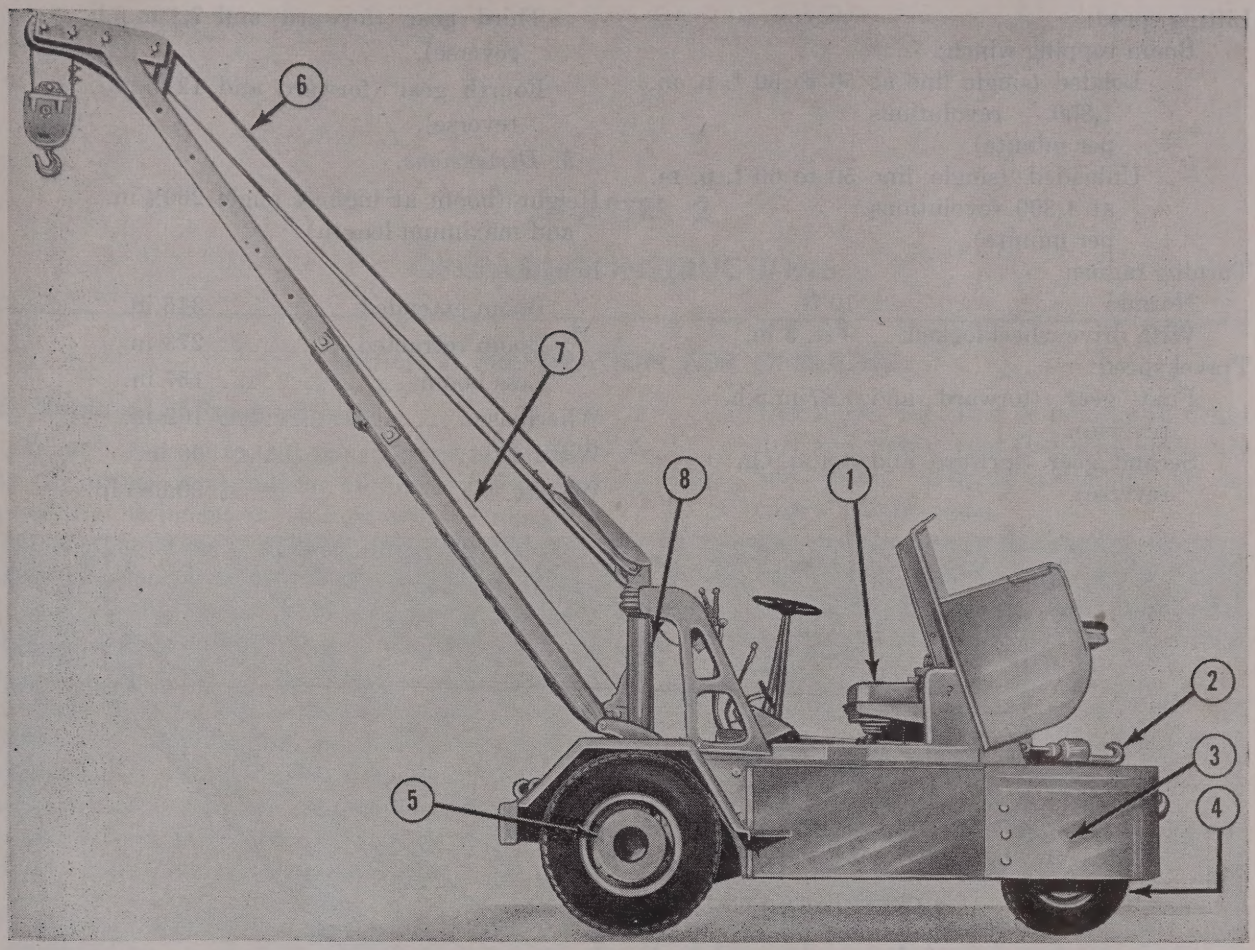
(2) *Steering axle.* The steering axle consists of the vertical spindle, the saddle box to which stub shafts are welded, and the steering wheels that are mounted on the stub shafts. The vertical spindle is held in place in the saddle box by a rocker pin so that the entire assembly pivots as a unit. The steering wheels are equipped with pneumatic tires on demountable rims and rotate on adjustable tapered roller bearings.

f. Brakes. Two brake systems—mechanical and hydraulic—are used to control the conventional two-shoe, internal-expanding brake assemblies on the drive axle. The mechanical system includes the two hand brake levers and linkage by which the operator can apply the brake to each drive wheel independently to shorten the turning radius when the crane is operated in close or crowded areas. The hydraulic system is the standard foot-operated type, operating through hydraulic cylinders to provide normal service brake application.

g. Turntable and Mast Assembly. The turntable and mast assembly is mounted at the front of the crane. It consists of the mast; mast support bracket; boom hinges to which the boom is attached; and the operating or sluing mechanism by which the mast and boom are slued.

h. Winch Asssemblies.

(1) *Boom topping.* The boom topping winch assembly, located on the left side of the crane, controls the raising and lowering of the boom. The winch is controlled by two friction-cone clutches which are operated by a hand lever in the operator's compartment. A brake on the winch worm shaft, automatically applied when the hand lever is in neutral position, maintains the boom at a constant level when the clutch is not engaged. Power for the boom topping winch is provided



1 Fuel tank
2 Towing hook
3 Rear frame section
4 Steering wheels
5 Drive wheels
6 Boom topping lines
7 Load hoist lines
8 Mast pipe

Figure 1. Hughes-Keenan V–10 crane—left side view.

by means of a V belt from the front engine power take-off pulley mounted on the crankshaft.

(2) *Load hoist.* The load hoist winch assembly, located on the right side of the crane, controls the raising and lowering of the load line and block. The winch is controlled by two friction-cone clutches which are operated by a hand lever in the operator's compartment. A brake on the winch worm shaft, automatically applied when the hand lever is in neutral position, maintains the load line and block at a constant level when the clutch is not engaged. Power for the load hoist winch is also provided by a V belt from the power take-off pulley on the engine crankshaft.

i. Boom. The boom is mounted to the turntable assembly on two trunnion brackets. It is composed of two telescopic sections that may be adjusted to lengths of 12 to 18 feet. Housed in the boom head are five sheaves for carrying the boom topping and load hoist cables.

5. Data

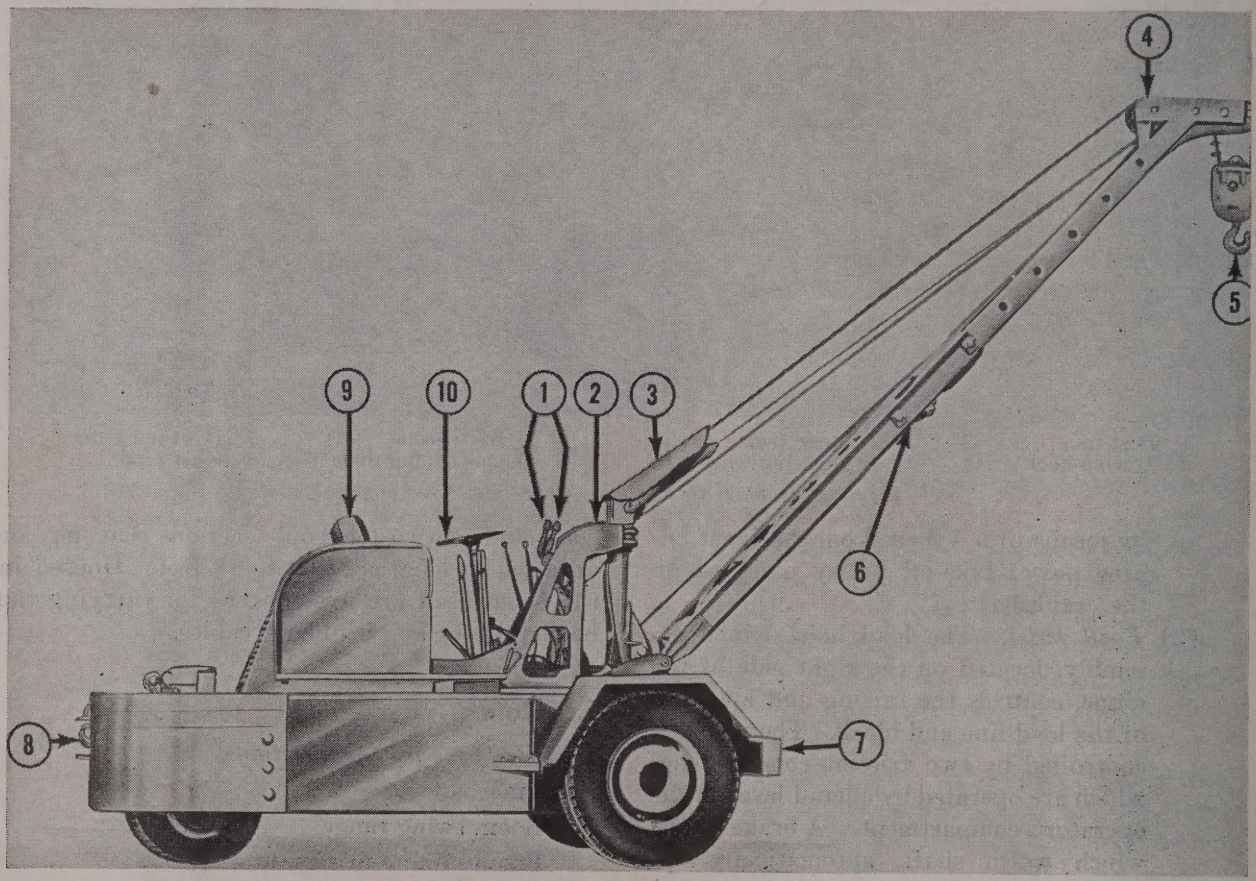
a. Performance Specifications.

Hoist mechanism:	
Boom swing range	190°
Boom minimum elevation	15°
Crane lift capacity:	
Maximum	10,000 lb.
Minimum (boom fully extended and horizontal).	2,000 lb.
Rated	10,000 lb.
Hoist winch capacity (single line).	5,000 lb.

Lifting speed:
Boom topping winch:
Loaded (single line at 1,800 revolutions per minute) 50 to 60 f. p. m.
Unloaded (single line at 1,800 revolutions per minute) 50 to 60 f. p. m.
Turning radius:
Normal 10 ft.
With drive wheel locked 9 ft. 3 in.
Travel speed:
First gear (forward and reverse) 1.87 m.p.h.
Second gear (forward and reverse) 3.8 m.p.h.
Third gear (forward and reverse) 7.1 m.p.h.
Fourth gear (forward and reverse) 12 m.p.h.

b. Dimensions.

Height (boom at highest angle and maximum length) 260½ in.
Length:
Boom extended 345 in.
Boom retracted 273 in.
Less boom 157 in.
Wheelbase 102 in.
Width 96 in.
Weight 20,680 lb.



1 Hand brake levers
2 Mast support
3 Boom topping line shield and dead-end arm
4 Boom head
5 Load block and hook
6 Boom
7 Bumper
8 Pintle hook
9 Operator's seat
10 Steering handwheel

Figure 2. Hughes-Keenan V–10 crane—right side view.

CHAPTER 2

OPERATING INSTRUCTIONS

Section I. PREPARATION FOR OPERATION

6. Removal of Preservatives

When a new or reconditioned crane is received at the using organization, all preservatives applied for shipment or storage will be removed. The compound sprayed over all exposed surfaces must be removed with dry cleaning solvent. As this compound is not a lubricant, special care must be taken to see that it is removed from all wearing surfaces. Preservative oil must be drained from the crankcase and the crankcase refilled with the recommended grade of engine oil as specified in Lubrication Orders 10–1692A–1 and 10–1692A–2. All paper must be removed from between belts and pulleys. All braces and protective tape must also be removed.

7. Initial Inspection

a. General. After the crane has been serviced as indicated in paragraph 6, operators or organization mechanics will continue the preparation for initial operation by inspecting all assemblies and subassemblies in accordance with the following procedure:

b. Procedure.

(1) See that fire extinguisher is present and in good condition. Test for proper operation. Install securely.

(2) Fill fuel tank. Inspect crankcase oil level and radiator water supply, following instructions on tag attached to filler cap or steering handwheel. In freezing weather, test value of antifreeze and add, as necessary, to protect cooling system.

(3) Inspect engine fuel pump for leaks or damage, making sure that it is properly mounted and all connections are tight. If dirt or water is found in fuel, remove fuel bowl and filter and clean bowl and filter screen with dry cleaning solvent. Disconnect fuel line at pump and drain dirt and water from fuel tank until fuel runs clean. Replace assembly and secure all connections.

(4) See that air cleaner is in good condition and secure. Remove element and clean thoroughly in dry cleaning solvent. Fill oil reservoir to prescribed level and reinstall securely.

(5) Conduct hydrometer and voltage test; add clean water until electrolyte is one-half of an inch above battery plates.

(6) Carburetor, generator, regulator, and starting motor, distributor, water pump, fan, oil filter, and other assemblies must be checked for good condition and secure installation. Make sure that fan, generator, and power take-off drive belts are in good condition and adjusted to have a 1-inch finger-pressure deflection midway between drive and driven pulleys. Adjust sluing output chain to have a ½-inch deflection midway between pinions.

(7) Examine all accessible wiring and conduits to see that they are in good condition, securely connected, and properly supported.

(8) Inspect tires for damage and remove objects lodged in treads or carcasses. Inflate to correct air pressure of 95 to 100 pounds.

(9) See that all wheel mounting and axle bearing adjusting nuts are present and secure.

(10) Inspect boom for secure installation. Inspect bumper for looseness or damage.

(11) See that all body mountings are securely fastened. Examine body for rust and see that all vehicle markings are legible.

(12) Lubricate the crane, covering all intervals, according to instructions in Lubrication Orders 10–1692A–1 and 10–1692A–2 (pars. 22 and 23). Verify all gear case oil levels, adding oil if necessary to bring to required height. Change only if justified by the condition of the lubricant, or if gear lubricant is not of the proper grade for anticipated temperatures.

(13) See that steering shafts, universal joints, and connecting linkage are in good condition and secure. See that gear cases are securely mounted and not leaking.

(14) Inspect winches for damage, secure mounting, and oil leakage. See that winch drive belts are in good condition, not excessively worn, and adjusted to have a ½-inch finger-pressure deflection between pulleys.

8. Trial Run

After the crane has been serviced and inspected, continue to prepare it for operation by conducting a trial run of sufficient duration to test operation at full loads. To do this, operate the crane in accordance with instructions in paragraph 12, performing the during-operation services listed in paragraph 20*b*.

9. Correction of Deficiencies

Correct deficiencies disclosed by inspection in one of the following ways:

a. New Equipment. Common deficiencies in the Hughes-Keenan V–10 crane will be listed on Form 468, Unsatisfactory Equipment Report, and forwarded to Inspection Liaison Office, Procurement Division, Office of the Quartermaster General, Washington 25, D. C. These deficiencies are the responsibility of the manufacturer and are not to be corrected at the expense of the using organization.

b. Used Equipment. Treat deficiencies noted in used or reactivated equipment in one of the following ways:

(1) Correct those within the scope of organizational maintenance.

(2) Refer deficiencies beyond the scope of organizational maintenance to a higher echelon for correction.

(3) Refer deficiencies of a serious nature to the supplying organization through proper channels.

Section II. CONTROLS AND INSTRUMENTS

10. Controls

The crane controls are divided into two groups: those which govern the operation of the engine, and those which control operation of the crane and its operating assemblies. Direction plates, indicating the manner in which shift levers must be moved for desired results, are located at the base of each lever.

a. Engine. The engine controls (fig. 3) consist of the ignition switch, starter button, choke control button, and accelerator pedal.

b. Crane. The crane controls (fig. 3) are the engine clutch pedal, foot brake pedal, hand brake levers, steering handwheel, engine transmission gear shift levers, boom topping shift lever, boom hoisting shift lever, and boom swing (sluing) shift lever.

11. Instruments

The instruments consist of the fuel gage, oil pressure gage, ammeter, temperature gage, and hour meter, and are located on the curved steel plate secured to the top of the mast support (fig. 3).

Section III. OPERATION UNDER USUAL CONDITIONS

12. Crane

a. Starting.

(1) Place the transmission gear shift lever in neutral position.

(2) Place choke control in desired position. The choke control should be used only when starting a cold engine.

(3) Turn ignition switch to ON position.

(4) Pull hand throttle lever about one-third of the way toward the operator.

(5) Press clutch pedal to floor.

(6) Push starter button, operating it no more than 30 seconds at a time.

(7) When engine starts, release starter button; push in choke control to point where

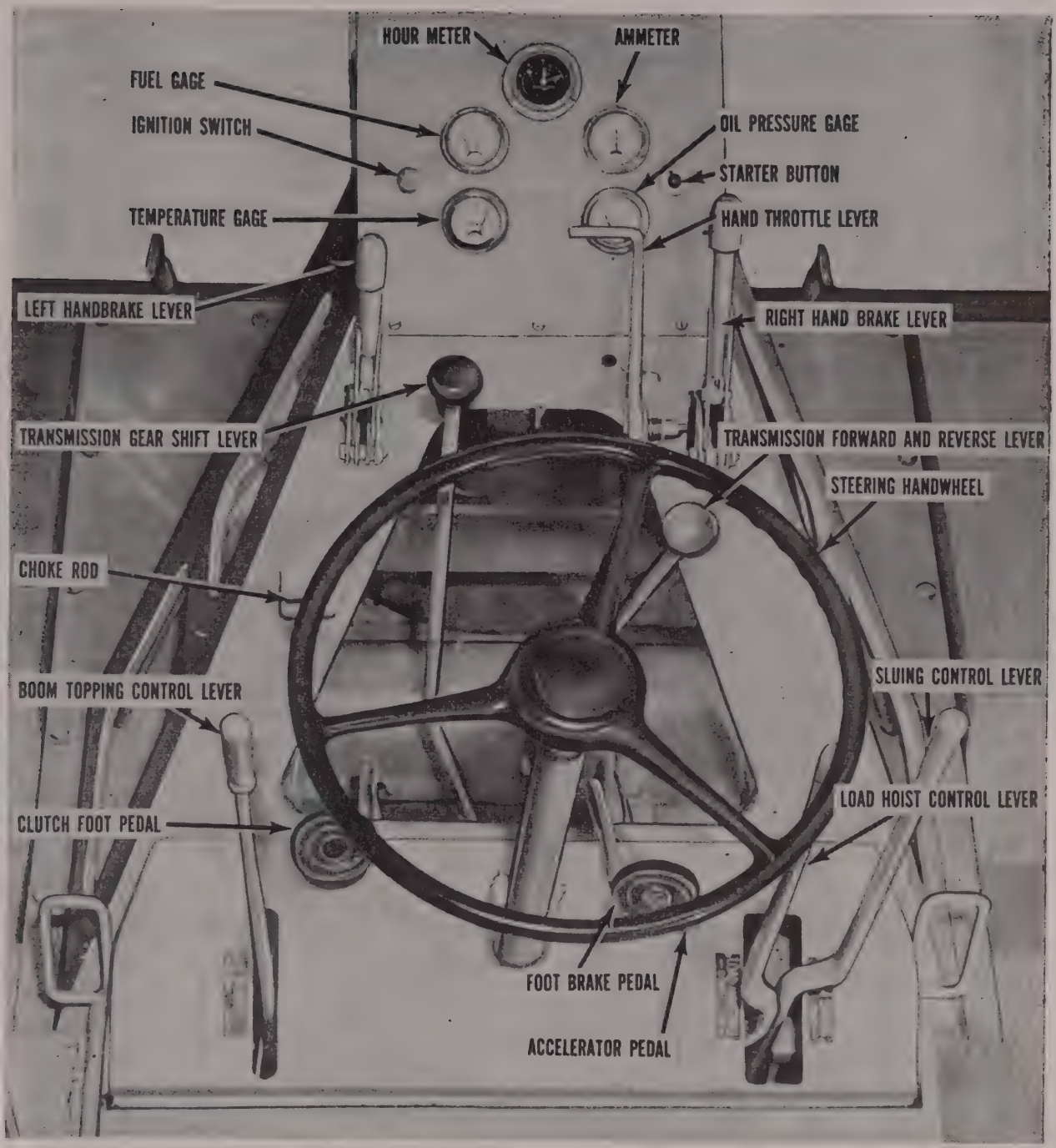


Figure 3. Controls and instruments.

engine functions smoothly, and all the way in when the engine is warm.

(8) Release clutch pedal.

b. Driving.

(1) Operate engine long enough to arrive at normal operating temperature (155° to 160° F.).

(2) Depress the clutch pedal and move transmission gear shift lever into first speed forward (fig. 4).

(3) Release hand brakes.

(4) Press down on the foot accelerator pedal to speed up the engine sufficiently to pick up the load.

(5) Release the clutch pedal slowly and further depress the accelerator pedal to prevent the engine from stalling while the vehicle is beginning to move forward.

(6) The speed of the crane may be controlled by depressing the accelerator pedal or pulling back on the hand throttle to increase; releasing the accelerator pedal or pushing the hand throttle forward to decrease. If the engine labors under the gear selected, depress the clutch pedal and select a lower gear.

(7) Obtain maximum speed without strain or racing of motor before shifting into a higher gear. Do not ride or slip clutch.

c. Stopping.

(1) Remove foot from accelerator pedal and return hand throttle to released position.

(2) Depress brake pedal with right foot and clutch pedal with left foot.

(3) If crane is to be parked, place all levers in a neutral position, shut off ignition switch, and set both hand brake levers to hold crane in position.

13. Hoist and Sluing Mechanisms

a. Lifting the Load.

(1) Drive the crane as close to the load to be lifted as possible, making sure that load will not strike the crane as it is lifted or carried.

(2) Move the boom swing lever to the left or right, as desired, to position the boom head over the center of the load.

(3) Move the boom topping lever forward or backward, as necessary, to suspend the load block directly over the load center, but not beyond the radius prescribed in figure 6 for safe handling of the load to be lifted.

(4) Move the load hoist lever forward until the load block has been lowered sufficiently to be secured to load.

(5) Secure the load hook to the load in such a manner that it will not swing as it is picked up and shift the load balance or damage the crane.

(6) Pull back on the load hoist lever and raise load. As slack is removed from the load line, accelerate engine slightly to avoid stalling.

(7) Hold the load hoist lever in the back position until load has been raised to the desired height, and then return the lever to the neutral position to hold the load in place. Use extreme care not to run the load up against the boom and thereby cause the cable to jam or break.

b. Sluing (Swinging) the Load.

(1) Make sure that no obstructions are in the path along which the load will travel when swung. Do not attempt to raise or lower the boom when it is under load.

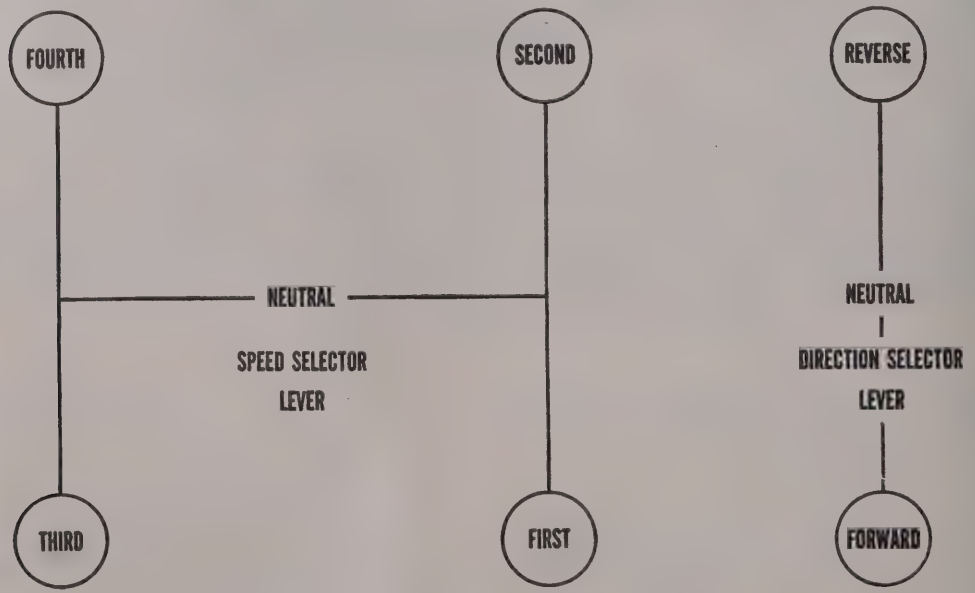


Figure 4. Transmission gear shift positions.

(2) Accelerate the engine slightly and shift the boom swing lever to swing the load to the left or right as desired. The boom swing mechanism must not be used to pull material from a pile or to drag material along the ground.

(3) The boom swing and load hoist controls may be operated at the same time if practicable. When operating the two controls simultaneously, accelerate the engine to avoid stalling.

(4) Use wire rope or a chain for lifting and swinging the load. The safe load capacity for wire rope or chain slings depends upon the size and type of the line used and the manner in which it is adjusted to the load. It will vary in relation to the angle between the legs of the sling. The angle formed by the legs of the sling is dependent upon the length of the sling employed; use a long sling rather than a short one when possible. The diameter of bar material from which sling rings are made is shown in figure 5. The capacities listed in the sling chart (fig. 5) are based on the use of a two-legged sling, formed with either of two conventional types of wire rope or with a chain at angles of 60°, 90°, and 120°.

To illustrate the method used in reading the sling chart, refer to figure 5 and, using 2 tons as an example, follow the explanation below:

(*a*) Proceed to the right from the figure 2 in the column headed TONS.

(*b*) Under the first of the three main divisions of the chart, headed 60° SLING, it may be seen that a ⅜-inch chain, a ½-inch 6 x 9 wire cable, or a ¼-inch four-part plaited cable may be used to form a sling to lift the 2-ton load, providing the cable or chain to be used is long enough to be placed around the load to be lifted and form an angle of 60° or less between the legs leading up to the load block hook. If the chain or cable to be used is not long enough to form an angle of 60° or less, and it is equal to or less than the diameter specified for a 60° sling, use a chain or cable of greater diameter, as the 60° sling offers the maximum mechanical advantage.

(*c*) Proceeding again to the right, the same method may be used to determine whether or not the cable or chain to be used will lift a load of 2 tons with a 90° or 120° sling.

	60° SLING				90° SLING				120° SLING			
TONS	CHAIN	6 x 9 WIRE CABLE	4-PART PLAITED CABLE	RING SIZE	CHAIN	6 x 9 WIRE CABLE	4-PART PLAITED CABLE	RING SIZE	CHAIN	6 x 9 WIRE CABLE	4-PART PLAITED CABLE	RING SIZE
	INCH	INCH	INCH	INCH	INCH	INCH	INCH	INCH	INCH	INCH	INCH	INCH
1	1/4	1/2	3/16	7/8	3/8	1/2	3/16	7/8	1/2	1/2	1/4	1-1/4
2	3/8	1/2	1/4	1-1/4	1/2	1/2	1/4	1-1/4	5/8	5/8	5/16	1-1/2
3	1/2	5/8	5/16	1-1/2	1/2	5/8	5/16	1-1/2	3/4	3/4	3/8	1-3/4
4	1/2	5/8	5/16	1-1/2	5/8	3/4	3/8	1-3/4	7/8	7/8	7/16	2
5	5/8	3/4	3/8	1-3/4	5/8	7/8	3/8	1-3/4	7/8	1	1/2	2-1/4
6	5/8	3/4	3/8	1-3/4	3/4	7/8	7/16	2	1	1	1/2	2-1/4
7	3/4	7/8	7/16	2	3/4	1	1/2	2-1/4	1-1/4	1-1/4	9/16	2-1/2
7-1/2	3/4	1	7/16	2	7/8	1	1/2	2-1/4	1-1/4	1-3/8	5/8	2-3/4

Figure 5. Sling chart.

(*d*) Sizes for ring stock to be used when fashioning rings for use with the load block hook may be found in the last column of each of the three main divisions covering the three types of slings.

(*e*) When using a three-legged sling, add 50 percent capacity; if using a four-legged sling, add 100 percent capacity.

(5) Refer to the load chart (fig. 6) for information regarding the maximum safe loads that may be carried by the boom. Procedure for reading this chart is outlined in a self-explanatory note on the chart.

c. Transporting the Load.

(1) Bring the load into line with the front bumper before moving the crane.

(2) Be sure that route of travel is free of obstructions. If size of load blocks vision, then the crane may be operated in reverse.

(3) When the load has been properly positioned for transporting, follow the prescribed procedure for driving, steering, and stopping.

d. Depositing the Load.

(1) When depositing a load in or upon other equipment, proceed with caution to avoid damaging the crane or the equipment to be loaded.

(2) Be careful to avoid breaking flanges or projections on the load or adjacent material.

(3) Note carefully the size and shape of load and determine the possible manner in which it may tip or lie before settling to the area on which it is to be deposited.

(4) Approach the area on which the load is to be deposited carefully. When destination has been reached, shift engine clutch lever into neutral position and apply both hand brakes before lowering load.

(5) Assign an assistant to arrange proper blocking under load before the load is lowered into place, and to aid in the maintaining of the proper positioning of the load or removal of the sling from the load. Move hoisting lever into DOWN position carefully, permitting load to lower slowly to resting point.

14. Suggestions and Cautions

a. Do not fill the fuel tank when ignition is turned on, when near an open flame, or when engine is extremely hot. Touch fuel container or metal hose to fuel tank before removing fuel tank filler cap. Keep metal hose or container in contact with the tank while it is being filled to avoid static electricity igniting gasoline vapor.

b. Keep air vent in fuel tank clean and open at all times to assure an even flow of fuel. Filler cap must be kept tight against gasket.

c. Do not pour cold water into cooling system when engine is hot; allow engine to cool, start engine again and pour water into cooling system. Turn radiator cap as far as the safety stop only, to release steam pressure before removing cap.

d. Keep crane in gear when descending steep hills or grades.

e. Reduce speed when making a turn.

f. Never dismount while crane is in motion. Wait until it stops.

g. Do not raise or lower the boom when loaded.

h. Do not run the load block up against the boom, as it may damage the cable and hoist mechanism.

i. Consult load chart and do not attempt to handle loads heavier than designated capacities.

j. Never permit persons other than the operator on the vehicle when it is in operation.

Section IV. OPERATION UNDER UNUSUAL CONDITIONS

15. Tropical Areas

a. Body. If paint is chipped or badly scratched, remove paint with paint remover, sandpaper, or sandblasting equipment. Apply two coats of red lead primer and, when dry, apply finishing coat of paint.

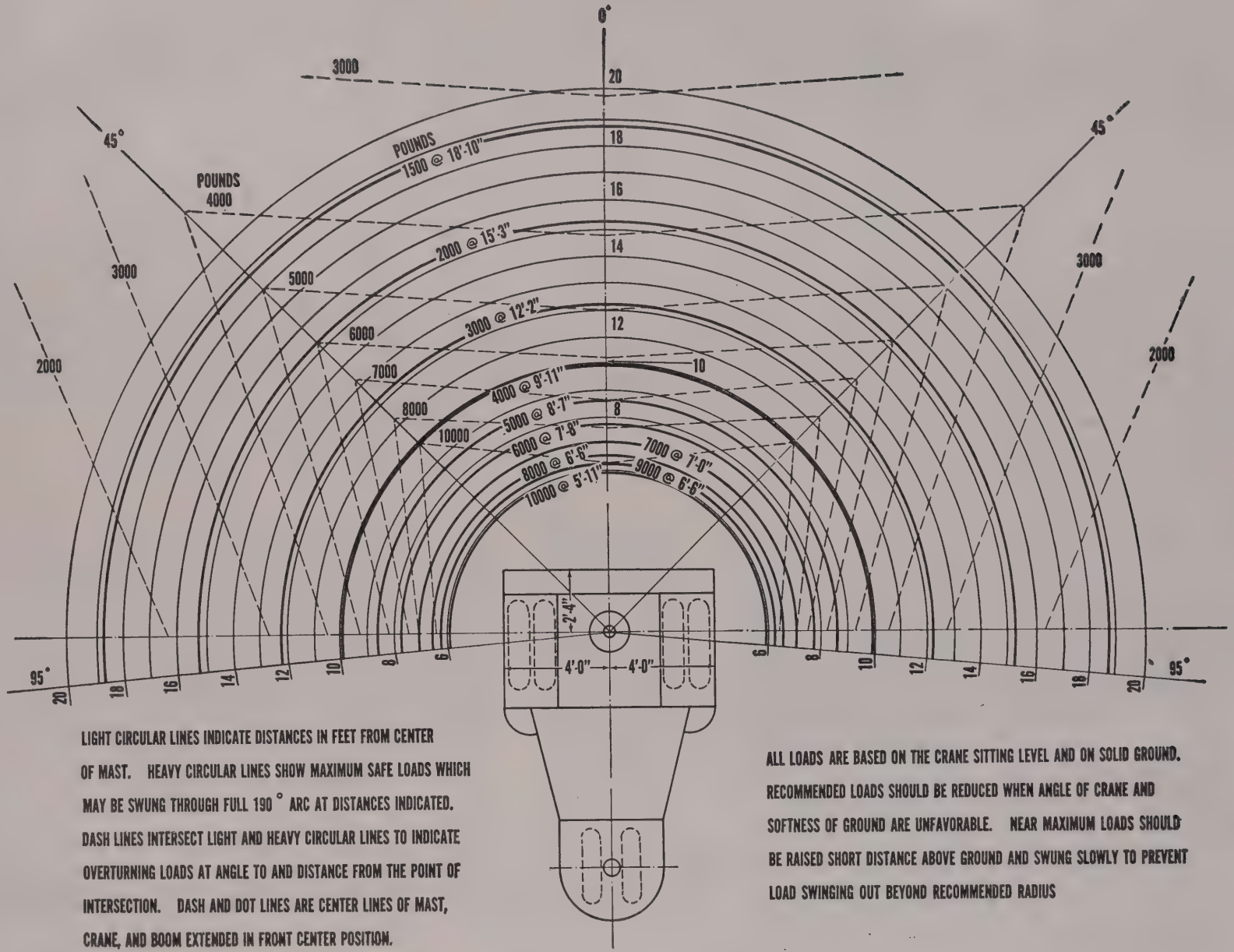
b. Cooling System.

(1) Verify correct fan belt deflection frequently.

(2) Check level of coolant in radiator frequently, making sure that radiator cap is tight and secure.

(3) Keep exterior of radiator clean, freeing spaces between radiator fins of bugs and other matter which might slow down circulation of air.

(4) Flush and clean cooling system at regular intervals.



LIGHT CIRCULAR LINES INDICATE DISTANCES IN FEET FROM CENTER OF MAST. HEAVY CIRCULAR LINES SHOW MAXIMUM SAFE LOADS WHICH MAY BE SWUNG THROUGH FULL 190 ° ARC AT DISTANCES INDICATED. DASH LINES INTERSECT LIGHT AND HEAVY CIRCULAR LINES TO INDICATE OVERTURNING LOADS AT ANGLE TO AND DISTANCE FROM THE POINT OF INTERSECTION. DASH AND DOT LINES ARE CENTER LINES OF MAST, CRANE, AND BOOM EXTENDED IN FRONT CENTER POSITION.

ALL LOADS ARE BASED ON THE CRANE SITTING LEVEL AND ON SOLID GROUND. RECOMMENDED LOADS SHOULD BE REDUCED WHEN ANGLE OF CRANE AND SOFTNESS OF GROUND ARE UNFAVORABLE. NEAR MAXIMUM LOADS SHOULD BE RAISED SHORT DISTANCE ABOVE GROUND AND SWUNG SLOWLY TO PREVENT LOAD SWINGING OUT BEYOND RECOMMENDED RADIUS

Figure 6. Load chart.

c. Battery. Check level of electrolyte frequently. Charge when necessary.

d. Lubrication. Follow instructions contained in Lubrication Orders 10–1692A–1 and 10–1692A–2.

e. Fuel System. Fill fuel tank at the end of the day to prevent condensation of moisture on interior tank surfaces during the cooler night. Be sure that vent in gas tank is open and that filler cap is tight.

f. Wiring System. Inspect wiring and conduits at regular intervals. Make sure that wiring is in good condition, and is dry and securely connected at terminals and points of support.

g. Hoist Mechanism. Inspect lubricant level in turntable and winch gear cases.

h. Engine. Keep engine clean and do not operate unless all cylinders are firing. Be sure that mountings, cylinder head nuts, and connections are tight.

16. Cold Areas

a. Shelter. Store crane in closed building or shelter as close to heat as possible. If shelter is not available, and crane must be kept ready for immediate use, cover it with tarpaulin or similar material. Park the crane with its front end to the wind.

b. Cooling System.

(1) Add antifreeze solution (ethylene glycol) in quantities prescribed for anticipated temperature, as shown in table I.

(2) When antifreeze compound is not available and the anticipated temperature is 32° F. or lower, the radiator must be drained if the crane is to remain motionless for any length of time. Test solution in radiator with antifreeze hydrometer before adding antifreeze compound.

Table I. Antifreeze Requirements

Temperature (Fahrenheit)	Ethylene glycol (quarts)
Plus 32° to plus 25°	2
Plus 24° to plus 16°	4
Plus 15° to plus 4°	6
Plus 4° to minus 12°	8
Minus 11° to minus 34°	10
Minus 33° to minus 62°	12

c. Electrical System.

(1) *Battery.* As the efficiency of a battery decreases at low temperatures, test specific gravity of the electrolyte frequently. A completely discharged battery will freeze at 20° F.

(*a*) Do not add water to a battery exposed to freezing temperature except when engine is running.

(*b*) If shelter for the crane is not available, remove the battery and store it in a warm place.

(2) *Wiring system.* Be sure that wires and conduits are in good condition, and that all connections are clean, dry, and secure.

(3) *Ignition.*

(*a*) Keep breaker distributor points clean and properly adjusted.

(*b*) Clean spark plugs and adjust gap.

(*c*) Be sure that all spark plug terminals and cable terminal sockets are clean.

d. Fuel System.

(1) Use prescribed grade of winter fuel.

(2) Fill tank at end of day to prevent condensation on tank interior surfaces.

(3) Before starting, pull the choke control rod all the way back. When engine starts, push choke rod in until engine operates smoothly. When engine becomes warm, return choke rod to released position.

e. Lubrication. Use cold weather lubricants prescribed in Lubrication Orders 10–1692A–1 and 10–1692A–2.

f. Hoist Mechanism. Avoid jerky operation and extreme loads as metal components are more easily broken when temperatures are cold.

17. Sandy Terrain

a. Fuel System.

(1) Use all available means to prevent sand from entering the fuel system. During sand storms, tie a loose bag made of a single layer of cloth, preferably loosely knit cotton, over the entire air cleaner.

(2) Be careful to prevent sand from entering the fuel tank when it is being refilled, making sure that tank cap is secure after refueling.

(3) Inspect the fuel sediment bowl for sand and dirt; inspect the air cleaner at more frequent intervals than normally specified.

b. Hoist Mechanism.

(1) Frequently inspect exposed parts of the mechanism, such as the sheaves, load block, winch drums, and cables, for accumulation of dust and dirt.

(2) Frequently disassemble, clean, lubricate, and reassemble parts to prevent damage.

(3) Lubricate more freely than normally to protect bearing surfaces from dust, dirt, or grit.

18. Towing the Crane

Two towing hooks are mounted on the front of the crane for attaching the tow bar or chain when the crane is to be towed.

a. Towing to Start Engine. Use following procedure if engine will not start:

(1) Attach tow bar or chain to pintle hook.

(2) Press clutch pedal to floor and shift transmission speed selector arm into high (fourth) gear.

(3) Keeping clutch fully depressed, shift directional shifter arm into forward position.

(4) Shift transmission of towing vehicle into low (first) gear.

(5) Move towing vehicle ahead slowly, avoiding a jerky, sudden application of power, to take up slack in chain or tow bar, thus preventing shearing of pintle hook.

(6) When crane is in motion, pull out ignition switch, pull back on choke control lever, pull back on throttle control lever or depress accelerator pedal, and slowly engage clutch.

b. Towing a Disabled Crane. If the engine starts but the crane will not move, raise the front of the crane before beginning towing operation which is described in *a* above.

CHAPTER 3

ORGANIZATIONAL MAINTENANCE

Section I. PREVENTIVE MAINTENANCE SERVICES

19. Responsibility

Preventive maintenance services are a responsibility of the using organization. These services consist of systematic inspections conducted at specified intervals so that defects may be discovered before they result in serious damage or failure.

20. Operator Responsibilities

Each operator must perform the following before-operation, during-operation, and after-operation services. In the performance of the before- and after-operation services he may be assisted by organization mechanics. The performance of the during-operation services are his sole responsibility.

a. Before-Operation.

(1) *Fuel, oil, and water.* Check levels of fuel, oil, and water. In season, check antifreeze protection.

(2) *Leakages.* Check crane for evidences of fuel, oil, water, brake fluid, and lubricant leakages.

(3) *Equipment.* See that horn and lights are operating properly. Check fire extinguisher. Check towing connections for good condition and secure mounting.

(4) *Tires and wheels.* Make sure that tires are inflated to pressure of 95 to 100 pounds. See that drive wheel mounting and flange nuts are securely tightened. Check casings and treads for condition.

(5) *Body and operator's seat.* Inspect crane body to see that all crane sections are properly joined and secure. Inspect cap screws that secure operator's seat frame to mounting supports. Tighten, if necessary.

(6) *Subassemblies and belts.* Inspect carburetor, air cleaner, starter, generator, water pump, oil filter, fuel lines, wiring, and shields for loose mounting, loose connections, or leakages. Check drive belts for proper deflection between pulley centers. Make certain belts are not frayed or broken.

b. During-Operation.

(1) Start engine and allow to warm up for at least two minutes. During this period, check instruments and gages. Make certain oil pressure gage indicates reading of 18 to 20 pounds with engine idling. Stop engine immediately and notify person in authority if oil pressure is not indicated within 30 seconds. Temperature gage should show gradual rise during warm-up period to temperature of 150° F. to 160° F. Ammeter should show high charge immediately after engine starts and then drop to a slight positive charge. Fuel gage should register FULL if fuel tank has been filled. Hour meter should begin to operate as soon as ignition switch is pulled to ON position. Test horn for operation and tone.

(2) Make certain that service brakes stop crane in a reasonable distance without side sway. Brake pedal should have one-fourth of an inch free travel before meeting push-rod-to-piston resistance. Test hand brakes individually, performing left and right turns with crane to make sure that inside drive wheel will lock in place while turn is being executed. Apply both hand brakes at the same time, leaving one-third lever travel in reserve, to make sure hand brakes will hold crane on reasonable incline.

(3) See that engine clutch operates smoothly without grab, chatter, or squeak on en-

gagement, or slipping when fully engaged. Adjust clutch pedal, if necessary, to provide a three-fourths of an inch free travel. Do not engage or disengage new clutch roughly or unnecessarily. Do not ride clutch pedal at any time.

(4) Accelerate engine momentarily and be alert for any unusual noise that might indicate damaged, loose, or worn engine parts, drive belts, or assemblies. Observe for any abnormal characteristics such as lack of pulling power or acceleration, backfiring, misfiring, stalling, overheating, or unusual exhaust smoke. Check instruments frequently during operation. Make certain that the oil pressure gage indicates 45 to 47 pounds per square inch when the engine is operating at normal speeds. See that temperature gage holds steady at normal operating range (150° to 160° F.).

(5) Test steering action for binding or looseness and note any side pull, wander, or shimmy. Be sure steering handwheel, column, and support bracket are secure. Note any defects in operation of steering system.

(6) See that gear shift mechanism shifts smoothly in all positions, operates, quietly, and does not jump out of mesh during operation.

(7) Test sluing and load hoist operation by swinging boom to left and right. Lift and lower load while boom is not in motion. See that the boom topping control lever operates freely and properly for up or down movement of the boom. Always disengage the engine clutch when engaging or disengaging the boom topping clutch. The boom topping and load hoist clutches should have positive action on both sides of shift lever neutral position without slip or chatter. There should be no drag on the clutches with shift levers in neutral position and no overriding when shift levers are returned to neutral after operation. The boom swing and boom topping automatic stops should neutralize clutch levers on contact. The winches should operate smoothly without brake drag or chatter; brakes should release as a load is lifted and set firmly to hold the load in place when power is removed from the winch. Check to see that the load hoist and boom topping winch brakes will hold the boom and load line in position when under full load.

(8) Observe movement of cables over sheaves when load or boom topping lines are in motion. See that cables are evenly seated on sheaves and that sheaves move freely on pins.

(9) Be alert for overheating in any units of the turntable assembly. Particular attention should be given to the sluing shaft bearings at either end of the sluing drive worm. In case of overheating, cease operation immediately and determine cause.

(10) See that load block is securely connected to load line and descends easily without load. See that load hook is securely set in load block and rotates freely on its bearing.

(11) Be alert throughout run-in test for unusual noises from running gear; crane frame and attachments; winch gears and sheaves; and suspensions and mounting brackets that might indicate looseness, binding, damage, wear, or inadequate lubrication.

c. After-Operation. The following services will be performed by the operator to correct deficiencies noted during operation and to complete inspection of the crane:

(1) Check fuel, oil, and water (par. 20*a*).

(2) Inspect and clean fuel bowl and screen.

(3) Inspect pintle hook and front and rear towing hooks for presence and good condition.

(4) Clean instrument panel and wipe off body, body attachments, and undercarriage.

(5) Lubricate all points for which daily lubrication is indicated on Lubrication Orders 10–1692A–1 and 10–1692A–2.

(6) Check for leakages.

(7) If movement of sluing drive chain has been noisy, inspect drive sprocket teeth for excessive wear. Inspect drive belts for correct alinement, signs of binding or other wear, and correct deflection midway between driving and driven units. Adjustment screws are provided for ad-

justing the position of winch drive pulleys to obtain the desired deflection in drive belts. Deflection of both sluing drive chain and drive belts should be one-half an inch.

(8) Be sure that power take-off shaft bearing retainers and lubricant seals are secure and not leaking. Check all oil seals and packing glands to see that they are secure and not leaking.

(9) Inspect cables for indication of excessive wear, fraying, broken strands, or kinks. Be sure that cables are wound evenly on drums and run over sheaves freely. Check cable clamps for security and good condition. Check cable ends to see that they are secure and that thimbles are wedged inside dead ends of cables.

(10) Inspect universal joints on steering system, load and boom hoist drive shafts, sluing drive shaft, and engine transmission output shaft for excessive play in bearings; inspect universal joint companion flanges for secure mounting.

(11) Investigate and correct steering defects noted during operation.

d. Weekly Services.

(1) Wash vehicle and clean engine and accessories. Avoid use of heavy streams of water in the near vicinity of electrical equipment or at points where damage might occur to bearing seals or water might accumulate and cause moving parts of crane to rust.

(2) Clean battery carrier and terminals. See that terminals and connections are tight and dry. Check electrolyte level and verify a specific gravity reading of 1.225 or higher.

(3) See that carburetor, generator, voltage regulator, starter, power take-off main pulley, and water pump connections are secure and properly mounted. Check drive belts for serviceability and pulleys for free and easy movement.

(4) Inspect the boom locking pins, the boom pivot pins, and sheaves for good condition and secure fastening. Inspect cables, cable fastenings, and load block for fraying, looseness, or damage.

(5) Inspect the turntable drive housing for secure mounting. Inspect for housing leaks and for proper housing lubricant levels. Be sure that sluing worm shaft bearing supports are properly secured. Examine drive chain to see that it has the proper deflection.

(6) Inspect the load hoist and boom topping winches for secure mounting. See that lubricant drain plugs in bottom of housings are secure. Examine gear housings for leaks and check lubricant levels. Inspect action of winch brakes, making sure action is positive and will brake drums properly. Test winch brakes for excessive heating and drag and adjust, if necessary.

(7) Inspect the load hoist, boom topping, and boom swing (sluing) clutches for secure mounting and proper adjustment and assembly of controls. Examine housings for lubricant leaks and presence of plugs. Inspect each transmission case lubricant level. Test clutches and, if necessary, adjust to provide proper operation.

(8) Inspect steering linkage for loose, bent, or inadequately lubricated parts. Correct, if possible, any defects present in steering system.

(9) Inspect universal joints on all shafts and adjust to eliminate excessive play in bearings; tighten all companion flange connections.

(10) When vehicle has been in operation long enough to require a regularly scheduled lubrication, proceed according to Lubrication Orders 10–1692A–1 and 10–1692A–2.

(11) See that all authorized tools and equipment are present, clean, and in serviceable condition.

21. Unit Mechanic Responsibilities

Preventive maintenance services performed by organization mechanics or maintenance crews are scheduled to provide adequate care for the crane under normal operating conditions. For abnormal conditions, the intervals may be shortened or lengthened accordingly.

a. Monthly or 100 Hours of Operation. This service is performed at the end of every 100 hours of operation or monthly, whichever occurs first. General instructions for the performance

of required services are listed on DA Form 465, Work Sheet for Materials Handling Equipment which the mechanics will use as a checklist.

b. Semiannual or 500 Hours of Operation. This service is performed semiannually or at the end of every 500 hours of operation, whichever occurs first. General instructions for the performance of required services are listed on DA Form 465, Work Sheet for Materials Handling Equipment.

c. Maintenance Chart. Table II, patterned after DA Form 465, indicates the services to be performed as part of the monthly and/or semiannual inspection.

Table II. Organizational Maintenance Chart

Interval		Service
M	S	
X	----	*Work test.* Operate crane, performing during-operation inspections listed in paragraph 20*b*.
X	----	*Clutch.* Make sure clutch pedal has a ¾- to 1-inch free travel. Observe clutch for slipping, grabbing, rattle, or failure to properly mesh gears.
X	----	*Radiator.* Inspect radiator core, shell, mountings, hose and cap for good condition, correct assembly, and absence of leaks. Remove dirt or other foreign matter from spaces between fins and straighten bent fins. Inspect coolant for contamination by rust, oil, or other foreign matter. Bring coolant in radiator to proper level and add rust inhibitor compound. When used, determine protective value of antifreeze solution.
X	----	*Water pump, fan, fan mounting frame, and fan belt.* Inspect water pump for good condition, secure installation, and absence of leakages. Examine fan blades for good condition and correct alinement. See that fan blades are properly secured to hub. Inspect fan mounting frame for secure mounting and proper alinement. Examine fan belt for fraying, correct seating, and deflection of 1 inch.
X	----	*Drive axles and differential.* Inspect axle and differential housing for good condition and absence of leakages. Check alinement of axles.
X	----	*Tires.* See that tires are in good condition and inflated to pressure of 95 to 100 pounds. Inspect tires for breaks, cuts, position of valve stems, and presence of valve caps. Remove foreign matter from treads or carcasses.
X	----	*Transmission.* Place crane in motion and shift gears into all positions. Observe whether levers move smoothly, noting any tendency of levers to slip out of engagement. Make sure transmission cases are securely mounted and not leaking.
X	----	*Battery.* Clean battery and inspect case for cracks and leakages. Inspect cables, terminals, and hook bolts and nuts for good condition. Recharge or replace battery if specific gravity reading is below 1.225. Make sure electrolyte level is one-half inch above plates. Perform high discharge rate test.
X	----	*Coil and wiring.* Inspect ignition coil and high and low voltage ignition wiring for good condition, cleanliness, and secure mounting.
X	----	*Distributor.* Clean distributor points and adjust breaker points to have a .024- to .026-inch gap. Adjust breaker arm pressure to 17 to 20 ounces. Make sure distributor is securely mounted.
X	----	*Generator and starting motor.* Inspect generator and starting motor for good condition, secure mounting, and cleanliness. Make sure that commutators and brushes are in good condition and brushes are free in holders. See that brushes have enough spring tension to hold them in contact with commutator, and that brush connecting wires are secure and not chafed. Check bearings and bushings for score or wear. Blow out commutator ends with compressed air and clean commutators with sandpaper.
X	----	*Spark plugs.* Inspect spark plugs for good condition, excessive carbon deposits, and burned electrodes. Examine insulation for breaks or cracks. Adjust electrode gaps to .023 to .027 inch. Replace defective plugs, using serviceable gasket.
------	X	Clean deposits from electrodes, insulation, and area surrounding spark plug ports.
X	----	*Regulator.* See that regulator is in good condition with all connections, mountings, and seals secure.
X	----	*Crankcase.* With engine idling, inspect crankcase, valve covers, and timing gear cover for oil leakages. If a change of lubricant is due, drain and fill to correct level with specified oil. Refill engine crankcase immediately after draining lubricant. Do not start engine after lubricant change until oil filter element has been changed.
X	----	*Cylinder head.* Inspect cylinder head for cracks or leakages. If leakages are indicated, and holddown nuts must be tightened, or cylinder head gasket must be replaced, check valve clearances after cylinder head has been adjusted.

Table II. Organizational Maintenance Chart—Continued

Interval M	Interval S	Service
X	----	*Manifolds.* Inspect intake and exhaust manifolds for good condition and absence of leakages.
X	----	*Oil filter.* Inspect oil filter for good condition, absence of leakages, and secure mounting.
X	----	*Air cleaner.* Inspect air cleaner for good condition, secure mounting, and cleanliness. See that air cleaner tube is in good condition and properly secured to carburetor and air cleaner.
X	----	*Carburetor.* See that carburetor operates properly at all engine speeds. Inspect for secure mounting and absence of leakages. Adjust carburetor as necessary.
X	----	*Fuel pump.* Be sure fuel pump and lines are in good condition, secure, and not leaking. Test fuel pressure and replace pump if necessary; make similar inspection of new pump.
X	----	*Fuel strainer.* Make sure that fuel strainer is securely mounted and not leaking. Clean strainer thoroughly; replace bowl gasket when necessary.
----	X	*Fuel tank.* See that fuel tank is in good condition and securely mounted. Inspect tank, lines, and fittings for leakages. Clean parts in breather cap. Replace gasket in filler cap, if necessary, and clean overflow pan.
X	----	*Governor.* Make sure governor is securely mounted and that linkage is properly connected. Adjust as necessary.
----	X	*Drums and supports.* Clean dirt and grease from drums and supports. Make sure that drums and supports are in good condition and securely mounted.
X	----	*Hydraulic lines.* Inspect brake lines, hoses, and fittings for good condition, secure support, and absence of leakages.
X	----	*Master cylinder.* See that master cylinder is in good condition and not leaking. See that stop light switch is in good condition, securely mounted, and connected. Inspect stop light switch wiring for insulation cracks or breaks.
X	----	*Pedal.* Be sure pedal free travel is one-eighth to one-fourth inch. Observe pedal for proper return spring action.
----	X	*Shoes.* Inspect brake linings for wear and replace if necessary. Be sure brake shoes are in good condition and apply evenly when actuated. See that shoes are properly secured to return spring and brake backing plate, move freely through guides, and that hand brake cable is securely connected to hand brake actuating lever, is not frayed, and does not bind in backing cable guide.
------	X	*Wheel cylinders.* See that wheel cylinders are in good condition and securely mounted. Replace leaking cylinder.
X	----	*Hand brakes.* See that hand brakes release easily. Make sure that ratchets hold firmly and that brake handles do not require more than two-thirds ratchet travel for normal braking action. Adjust if necessary.
X	----	*Boom, boom cables, and load block.* Inspect boom locking pins, boom pivot pins, and sheaves for good condition and secure assembly. See that boom extension rack moves freely along boom extension pinion. Inspect cables and cable clamps for fraying, damage, or looseness. Inspect load block for correct assembly, and see that sheaves and hook move freely on their mountings. Lubricate sheaves, pins, and extension rack as required.
X	----	*Boom automatic stops.* Test function of boom topping automatic stop by raising boom to contact; observe engine distributor for a short. Swing boom both ways and see that safety stops on turntable contact boom swing clutch lever and neutralize clutch from either direction.
X	----	*Cables and sheaves.* Examine cables for fraying or other signs of weakness. Be sure that all cable fastenings are in good condition and secure. Inspect sheaves and load block for cracks, broken flanges, or worn bushings. See that all sheaves are securely installed and rotate without looseness or binding.
X	----	*Boom swing clutch.* Adjust the boom swing clutch as required to provide positive engagement without slippage. Examine chain drive for wear and secure assembly, and examine drive belt for proper deflection and alinement. Inspect clutch for secure mounting and lubricant leaks. Inspect mast for proper mounting and alinement of frame. Examine sheaves for evidence of bushing wear; secure attachment. Inspect yoke attachment and see that sheave and yoke pins are secure.
X	----	*Boom topping and load hoist clutch.* Examine belts from main to side power take-offs for fraying, alinement, and proper deflection. Inspect clutch housing for lubricant leakages. Adjust clutch linkages to provide positive load control. Avoid adjusting too closely, causing constant contact between clutch surfaces.
------	X	*Pintle and towing hooks.* Inspect for presence, good condition, and secure mounting.

Table II. Organizational Maintenance Chart—Continued

Interval M	Interval S	Service
X	----	*Power take-offs.* Inspect side and main (engine) power take-off pulleys for secure mounting and adequate lubrication. Check drive belts for alinement, wear, and proper deflection. Shake all power take-off pulleys to see that play in shaft or bearings is not excessive.
X	----	*Turntable.* Inspect the turntable and sluing drive housings for secure fastening. Inspect housings for lubricant level and lubricant leaks. Examine sluing clutch drive belt and turntable drive chain for proper deflection. Be sure that turntable worm shaft bearing supports are properly secured.
X	----	*Winch brakes.* Tighten winch brakes as required to provide desired drag under prescribed load capacities. Avoid overtightening, which will cause excessive drag and overheating. Inspect shoes and linings for proper alinement and good condition.
X	----	*Winch drive assemblies.* Inspect load hoist, boom topping, and boom swing universal joint drive assemblies for excessive play in joint bearings and proper lubrication.
------	X	*Winches and winch controls.* Inspect mountings of both boom topping and load hoist winches for security. Examine control linkages for secure mounting and satisfactory operation. Adjust linkages to provide positive action. See that winch worm and clutch housings are properly mounted and lubricated.
X	----	*Steering axle.* Check rocker pin for secure installation. Inspect axle and axle linkage for secure installation and proper lubrication.
X	----	*Steering gear, column, and linkage.* Be sure gear and column are securely mounted. Inspect gear for excessive play and lubricant leakages. Inspect linkage for loose sockets and improper adjustment.
X	----	*Steering handwheel.* Make sure that there is no looseness or binding and that free play does not exceed 1 inch.
X	----	*Wheels.* See that wheels are securely mounted. Examine for lubricant leakage.

Section II. LUBRICATION

22. General Instructions

Lubrication Orders 10–1692A–1 and 10–1692A–2 (figs. 7 and 8) prescribe organizational lubrication maintenance instructions. The intervals specified on the orders are for normal operating conditions. Time between service intervals may be shortened or extended commensurate with adequate preservation to compensate for unusual operating conditions such as immersion of crane in water and prolonged operation in sandy or dusty areas. Compliance with the instructions in the lubrication orders is mandatory at all levels of maintenance, and, if a crane is received without copies of the orders, copies must be requisitioned in accordance with instructions in SR 310–90–1.

23. Specific Instructions

a. Lubrication Equipment. Clean lubrication equipment thoroughly before and after use. Apply even pressure to lubricating gun to insure even distribution of lubricant.

b. Points of Application. Lubrication fittings, grease cups, oilers, and oil holes are readily identified by reference to the lubrication orders. Wipe lubrication points and surrounding surfaces clean before applying lubricant. Where relief valves are provided, apply lubricant until old lubricant is forced from vent.

(1) *Transmission cases.* Grease hole plug is located on left side of each case. Fill to plug level with GO.

(2) *Load hoist and boom topping winch cases.* Fill to level of filler plug just below center of cases marked OIL LEVEL.

(3) *Sluing transmission case.* Fill to level of oil hole just above bottom of case marked OIL LEVEL.

(4) *Steering worm and worm gear case.* Fill steering worm case at rear end of crane to level of lower side of worm gear through pipe plug opening in cover plate.

(5) *Steering column bevel gear case.* Grease fittings are located in top end cap and output shaft housing. Apply GAA with grease pressure gun.

(6) *Boom sluing worm gear and worm.* Lu-

LUBRICATION ORDER

LO 10-1692A-1

27 July 1953

CRANE, WHEELED, SLUING, GASOLINE, 10,000-POUND
(HUGHES-KEENAN "V-10" and "V-10(RS)")

Intervals given are maximums for normal 8-hour operation. For abnormal conditions or activities, intervals should be shortened or lengthened commensurate with adequate preservation.

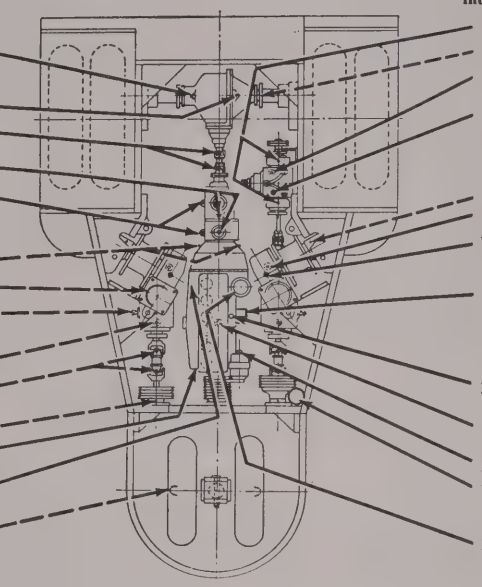
Lubricate points indicated by dotted arrow shafts on both sides of the equipment.

Wash crane and clean fittings before lubricating.

Clean parts with Solvent, dry-cleaning (Stock No. 51-S-4387-55). Dry before lubricating.

Drain crank and gear cases only when hot. Verify level and replenish when cool.

	Lubricant	Interval
Differential Fill and Level Verify level; add GO if necessary. (See Note 1)	GO	M
Differential Drain		S
Propeller Shaft Universal Joints	GAA	M
Transmission Drain		S
Transmission Fill and Level Verify level; add GO if necessary. (See Note 1)	GO	M
Clutch Throwout Shaft	GAA	M
Winch Brake Housing	GAA	M
Winch Transmission Case Fill Verify level; add GO if necessary. (See Note 1)	GO	M
Winch Transmission Case Drain		S
Winch Drive Universal Joints	GAA	M
Winch Drive Bearing	GAA	M
Water Pump (See Note 4)	WP	M
Starting Motor 6 to 8 drops (See Note 5)	PL	M
Wheel Bearing	GAA	S



Interval	Lubricant	
M	GAA	Clutch Bearing
M	GAA	Differential Sleeve
S		Sluing Transmission Drain
M	GO	Sluing Transmission Fill and Level Verify level; add GO if necessary. (See Note 1)
M	GAA	Winch Hoist Drum Bearing
S		Winch Worm Gear Case Drain
W	GO	Worm Gear Case Fill Verify level; add GO as required. (See Note 1)
S		Distributor (See Note 6)
D	OE	Crankcase Level Verify level; add OE if necessary
M	OE	Crankcase Fill (See Note 2)
S		Crankcase Drain (See Note 2)
M	PL	Generator
D	OE	Air Cleaner Verify level. Capacity 1 pt. (See Note 3)
M		Oil Filter Clean case and install new element

—KEY—

See LO 10-1692A-2 for Notes

LUBRICANTS	EXPECTED TEMPERATURES			INTERVALS
	above plus 32° F.	plus 40° F. to minus 10° F.	0° F. to minus 65° F.	
OE—OIL, engine, heavy duty	OE-30	OE-10	OES	D . . . Daily
PL—OIL, lubricating, preservative	PL-Medium	PL-Special	PL-Special	W . . . Weekly
GO—LUBRICANT, gear, universal	GO-90	GO-75	GOS	M . . . Monthly or every 100 operating hours, whichever occurs first
CW—LUBRICANT, chain, exposed gear and wire rope	CW-IIB*	CW-IIA	CW-IIA	S . . . Semiannually or every 500 operating hours, whichever occurs first
HB—FLUID, hydraulic, brake		HB		
GAA—GREASE, autom		temperature		
WP—GREASE, lubricating,		temperature		
OES—OIL, engine, Sub-Zero				
GOS—LUBRICANT, gear, universal, Sub-Zero				
HBA—FLUID, hydraulic, brake, Arctic				*Use CW-IIC grade only in constant high temperatures as in tropics.

Figure 7. Lubrication Order 10–1692A–1.

LUBRICATION ORDER

LO 10 - 1692A - 2

27 July 1953

CRANE, WHEELED, SLUING, GASOLINE, 10,000-POUND
(HUGHES-KEENAN "V-10" and "V-10(RS)")

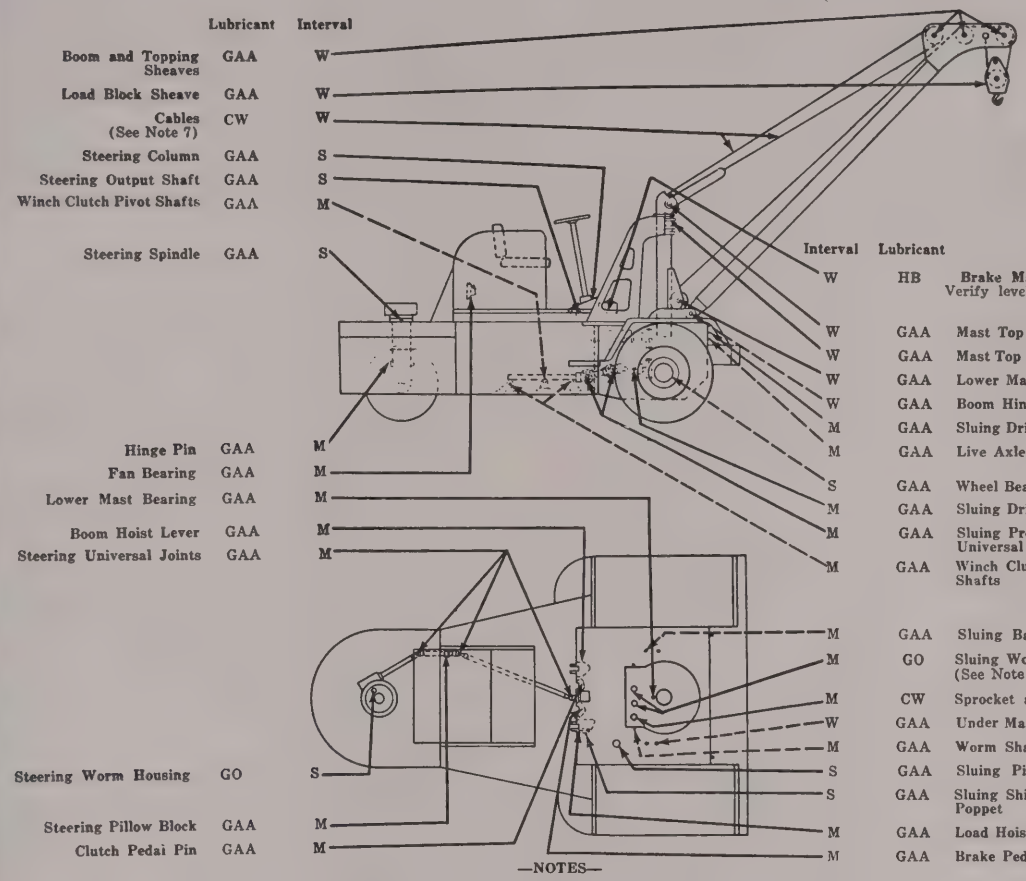
Intervals given are maximums for normal 8-hour operation. For abnormal conditions or activities, intervals should be shortened or lengthened commensurate with adequate preservation.

Lubricate points indicated by dotted arrow shafts on both sides of the equipment.

Wash crane and clean fittings before lubricating.

Clean parts with Solvent, dry-cleaning (Stock No. 51-S-4387-55). Dry before lubricating.

Drain crank and gear cases only when hot. Verify level and replenish when cool.



	Lubricant	Interval
Boom and Topping Sheaves	GAA	W
Load Block Sheave	GAA	W
Cables (See Note 7)	CW	W
Steering Column	GAA	S
Steering Output Shaft	GAA	S
Winch Clutch Pivot Shafts	GAA	M
Steering Spindle	GAA	S
Hinge Pin	GAA	M
Fan Bearing	GAA	M
Lower Mast Bearing	GAA	M
Boom Hoist Lever	GAA	M
Steering Universal Joints	GAA	M
Steering Worm Housing	GO	S
Steering Pillow Block	GAA	M
Clutch Pedal Pin	GAA	M

Interval	Lubricant	
W	HB	Brake Master Cylinder Verify level; add HB as required
W	GAA	Mast Top Sheaves
W	GAA	Mast Top Bearing
W	GAA	Lower Mast Sheave
W	GAA	Boom Hinges
M	GAA	Sluing Drive Gear
M	GAA	Live Axle Bearing
S	GAA	Wheel Bearing
M	GAA	Sluing Drive Shaft
M	GAA	Sluing Propeller Shaft Universal Joints
M	GAA	Winch Clutch Shifter Shafts
M	GAA	Sluing Ball Race
M	GO	Sluing Worm Gear Case (See Note 1)
M	CW	Sprocket and Chain
W	GAA	Under Mast Sheave
M	GAA	Worm Shaft Bearing
S	GAA	Sluing Pillow Block
S	GAA	Sluing Shifter Shaft Poppet
M	GAA	Load Hoist Lever
M	GAA	Brake Pedal Pin

—NOTES—

See LO 10-1692A-1 for Key

1. GEAR CASES—S, drain only when hot. Fill to plug level when cool. Capacities: Differential: 4 qts.; Sluing transmission case: 1 pt.; Sluing worm gear case: 1 pt.; Engine Transmission (forward and reverse cases) 4 qts.; Winch worm gear case: 5 pts.; Winch reversing transmission case: 4 pts.

2. CRANKCASE—M, or after every 100 operating hours, whichever occurs first, drain and refill with OE. Refill to full mark, then run engine a few minutes and add oil as necessary to return level to full mark. Capacity: 5 qts.

3. AIR CLEANER—M, drain, clean, and refill with OE.

4. WATER PUMP—On units not equipped with fittings, no additional lubrication is required.

5. STARTING MOTOR—S, remove motor; clean mechanism and oil lightly; lubricate outboard bearing with 6 to 8 drops of OE.

6. DISTRIBUTOR—S, wipe breaker cam lightly with GAA; lubricate breaker arm pivot and wick under rotor with 1 or 2 drops of OE. Distributor shaft is lubricated by means of a grease cup; M, turn down grease cup one full turn.

7. CABLES—D, wash and oil with CW-IIA or CW-IIB as required. W, if cable has not been used, coat outer coils on drums. M, completely unwind cables, wash and oil.

8. OIL CAN POINTS—W, lubricate throttle, clutch, brake, and steering linkages and shafts and other rubbing surfaces with OE.

Copy of this lubrication order will remain with the equipment at all times; instructions contained herein are mandatory and supersede all conflicting lubrication instructions dated prior to the date of this lubrication order.

BY ORDER OF THE SECRETARY OF THE ARMY:

J. LAWTON COLLINS
Chief of Staff, United States Army

OFFICIAL:
WM. E. BERGIN
Major General, USA
The Adjutant General

Figure 8. Lubrication Order 10–1692A–2.

bricate by removing caps directly over worm in sheet metal cover. Fill to proper level with GO.

c. Capacities.

Air cleaner	1 pt.
Cooling system	20 qt.
Crankcase	5 qt.
Differential	4 qt.
Fuel tank	20 gal.
Transmissions:	
Engine	4 qt.
Sluing	1 pt.
Winch	4 pt.
Sluing worm gear case	1 pt.
Winch worm gear case	5 pt.

Section III. TROUBLESHOOTING

24. General

Troubleshooting is a responsibility of the using organization and may be defined as the process of locating and correcting malfunctions that may occur under normal conditions of operation and usage.

25. Troubleshooting Chart

The information contained in table III is confined to the diagnosis and correction of common troubles by personnel and facilities of the using organization. It is to be used as a guide for locating sources of unsatisfactory operation and determining whether major repairs are necessary. Abnormal conditions such as excessive oil consumption; difficulty in shifting the transmission; unusual noises or indications of clutch, axle and steering gear malfunction; and improper performance of major hoisting and sluing assemblies must be reported to the designated individual in authority.

Table III. Troubleshooting Chart

Trouble	Cause	Remedy
Engine will not turn over	Dead battery or loose leads to starting motor.	Blow horn. If horn does not sound, charge or replace battery. If horn sounds, check leads to starting motor terminals.
	Piston lock or seizure	With ignition off, try to crank engine by hand. If engine does not turn, report to designated individual in authority.
Engine turns but will not start	Weak battery	Charge or replace battery.
	Faulty ignition or fuel system	Disconnect one spark plug lead and hold it about three-sixteenths of an inch from engine block. Crank engine to see whether lead arcs to block. If strong spark occurs, engine should be operating normally. Check fuel system. If strong spark does not occur, check engine coil and distributor.
	Defective distributor	Remove coil lead from center of distributor cap. Hold lead about three-sixteenths of an inch from engine block. Crank engine. If spark results, distributor is defective and must be inspected, tested, and replaced, if necessary.
	Defective coil	Ignition coil is defective if no spark is obtained and must be inspected, tested, or replaced, if necessary.
	Distributor shorted by automatic boom stop.	If boom stop points are closed, insert piece of paper between points; then adjust points.
	No fuel in tank	Fill tank.
	Carburetor flooded	Place ignition switch in off position and wait several minutes before attempting to start engine.
	Fuel not reaching carburetor	Detach outlet fuel line at fuel pump. Blow through line to make sure it is not clogged. With ignition switch in off position, crank engine with starter. If fuel does not flow through line, the fuel pump is defective and must be inspected, tested, and replaced, if

Table III. Troubleshooting Chart—Continued

Trouble	Cause	Remedy
		necessary. If fuel flows through line, carburetor is defective and must be inspected and replaced, if necessary.
Engine does not develop full power	Air cleaner clogged	Clean air cleaner.
	Fuel pump clogged	Clean fuel pump.
	Fuel lines clogged.	Clean fuel lines.
	Intake manifold leaking	Tighten manifold stud nuts until secure.
Engine misses	Defective spark plug	With engine operating at slow speed, short out spark plug with a screwdriver by placing bit between spark plug terminal and engine block. If plug is defective, no change will occur in engine performance and plug must be replaced.
	Intake manifold leaking	Tighten manifold nuts.
	Spark plug improperly gapped	Set gap at .025 inch.
	Breaker points sticking or improperly set.	Clean and set point opening at .022 inch.
Engine overheats	Lack of water	Fill radiator.
	Fan belt loose	Adjust to a 1-inch finger-pressure deflection midway between pulleys.
	Cooling system clogged	Clean and flush system. Clean radiator and blow out dirt, insects, and other foreign matter from radiator core.
Spark, fuel, and valve knocking	Low grade fuel	Drain fuel tank and refill with proper grade fuel of 70 to 80 octane.
	Fouled spark plugs	Clean; set gap to .023 to .027 inch; replace, if necessary.
No oil pressure	Insufficient oil in crankcase	Stop engine immediately. Fill crankcase to level indicated on Lubrication Orders 10–1692A–1 and 10–1692A–2. Check for leakages before operating engine.
	Inaccurate oil pressure gage	Test pressure gage. Normal pressure at idle speed is 6 to 8 pounds and at operating speed at least 45 pounds.
Ammeter shows constant discharge	Generator belt loose or broken	Tighten or replace belt.
Brakes drag	Weak brake retracting spring	Replace spring.
	Clogged or restricted lines	Clean lines.
	Loose wheel bearings	Take up with adjusting nut.
	Pedal improperly set	Adjust pedal linkage to provide a ¼- to ½-inch free play.
Ineffective brakes	Air in system	Bleed system.
	Fluid low in master cylinder	Fill master cylinder to one-quarter inch below top.
	Leaks in system	Check system and correct.
	Blockage in line	Clean lines.
	Loose wheels	Tighten wheel nuts.
Springy, spongy, brake pedal	Air in system	Bleed system.
Crane pulls to one side when foot brakes are applied.	Tires not properly inflated	Inflate tires to 95 to 100 pounds pressure.
	Lack of lubrication	Lubricate in accordance with Lubrication Orders 10–1692A–1 and 10–1692A–2.
	Steering wheel tire worn on either side.	Remove tires, reverse, and reinstall.
Crane steers improperly	Wheel bearings out of adjustment.	Adjust bearings.
	Unequal tire pressures	Inflate tires to prescribed pressures.
Shimmy	Unequal tire pressures	Inflate tires to prescribed pressures.
	Tires not balanced	Balance with wheel balance weights.
Power take-off failure	Improperly lubricated	Refer to Lubrication Orders 10–1692A–1 and 10–1692A–2.

Table III. Troubleshooting Chart—Continued

Trouble	Cause	Remedy
	Improper drive belt adjustment	Adjust drive belts to ½-inch finger-pressure deflection.
Boom swing failure	Turntable worm gear drive chain broken.	Replace chain.
	Sluing clutch drive belt broken	Replace belt.
	Clutch slipping	Adjust clutch.
Boom overrides when swung	Clutch does not brake properly	Tighten clutch adjustment.
	Clutch adjustment too tight	Loosen clutch adjustment.
Boom jerks when swung	Boom swing brake too tight	Adjust brake.
	Mounting pins at boom base worn.	Replace pins.
Clutch runs hot	Improper clutch adjustment	Adjust clutch for proper engagement.
	Lack of lubricant	Inspect level and fill.
Sluing control lever jumps out of position.	Improper clutch adjustment	Adjust clutch and test.
Load hoist failure	Clutch drive belt broken	Replace belt.
	Clutch slipping	Adjust clutch.
Load hoist clutch slips	Improper clutch adjustment	Adjust clutch.
Clutch runs hot	Improper clutch adjustment	Adjust clutch.
Hoist jerks	Clutch adjustment too close or too loose.	Adjust clutch for even engagement.
Load block continues to move when clutch lever is in neutral position.	Clutch adjustment too close	Adjust clutch.
	Brake defective or too loose	Adjust brake.
	Reversing clutch adjustment too close.	Adjust clutch.
Winch drive assemblies run hot	Lack of lubricant	Fill to correct level.
Boom topping winch failure	Drive belts broken	Replace entire set of drive belts.
Noisy winch operation	Lack of lubricant	Fill to proper level.
Winch runs hot	Lack of lubricant	Fill to proper level.
	Brake too tight	Adjust brake.
	Brake defective or too loose	Adjust brake.
Cable does not wind evenly on drum and binds in sheaves.	Sheave bearings defective or seized.	Clean and lubricate or replace sheave bushings.
	Cable badly frayed	Replace cable.

Section IV. UNIT MAINTENANCE INSTRUCTIONS

26. Engine Tune-Up

Engine tune-up is the systematic checking of the engine and accessory equipment to maintain or restore satisfactory engine performance. Engine tune-up must be accomplished semiannually and may be accomplished whenever engine performance indicates the need for these services.

a. Compression Test.

(1) Start engine and allow it to warm up until normal operating temperature is reached.

(2) Test battery for full charge. If battery does not meet minimum testing specifications, replace with a fully-charged battery.

(3) Remove spark plug cables from spark plugs; remove spark plugs.

(4) Attach a compression gage in front spark plug port.

(5) With choke and throttle fully open, crank engine with starting motor until maximum reading on gage has been reached. Record the reading on DA Form 465, and identify it as No. 1 cylinder reading.

(6) Repeat this operation on the remaining five cylinders.

(7) If readings indicated by compression gage are reasonably high (110 pounds) and do not vary more than 5 pounds between cylinders, compression may be considered normal.

(8) If readings do vary by more than 5 pounds or are abnormally high or low,

report to the designated person in authority, as these conditions indicate lead or carbon deposits in cylinders or leakage past piston rings, valves, or gaskets. These troubles can be corrected only by disassembly of the engine for repair.

b. Electrical System.

(1) Clean spark plugs thoroughly. Adjust spark plug gap to .023 to .027 inch. Replace spark plugs if necessary.

(2) Clean, dress, and adjust distributor points. Replace points if necessary. Inspect, clean, and remove dust and dirt from spark plug cables and distributor cap terminal sockets.

(3) Clean terminals on top of generator. Remove commutator band and clean commutator with No. 00 sandpaper. Inspect generator drive belt.

(4) Inspect starting motor connections. Remove commutator cover band and clean commutator with No. 00 sandpaper. Inspect Bendix starter for correct operation.

c. Fuel System.

(1) Clean fuel pump sediment bowl and reinstall, using a new gasket. Check fuel pump pressure. It must be 4 to 5 pounds per square inch.

(2) Inspect fuel lines for secure mounting and absence of leaks.

(3) Remove, inspect, and service air cleaner.

(4) Check choke and throttle linkage.

d. Valve Tappet Adjustment.

(1) Lift operator's seat.

(2) Remove intake and exhaust manifold assembly.

(3) Remove valve chamber cover stud nuts. Remove valve covers and gasket.

(4) With engine cold, adjust intake valve clearance to .009 to .011 inch and exhaust valve clearance to .013 to .015 inch. To increase tappet clearance, hold tappet with wrench as shown in figure 9 and turn adjusting screw clockwise. To decrease tappet clearance, hold tappet and turn adjusting screw counterclockwise.

e. Vacuum Test. Before making vacuum test, make certain that cylinder head is properly tightened. Tighten cylinder head stud nuts to 65 to 70 foot-pounds, if necessary, using a torque wrench and following the sequence shown in figure 10. Use the vacuum gage when making carburetor adjustments. Make certain air cleaner is installed when final test is made.

(1) Tighten manifold stud nuts to prevent leakage at gaskets and remove pipe plug from instake manifold; attach vacuum gage.

(2) Start engine and allow it to warm up until normal operating temperature has been reached.

(3) Set idle stop screw on carburetor at position for lowest smooth idling speed. Turn the stop screw clockwise to increase speed; counterclockwise to decrease speed.

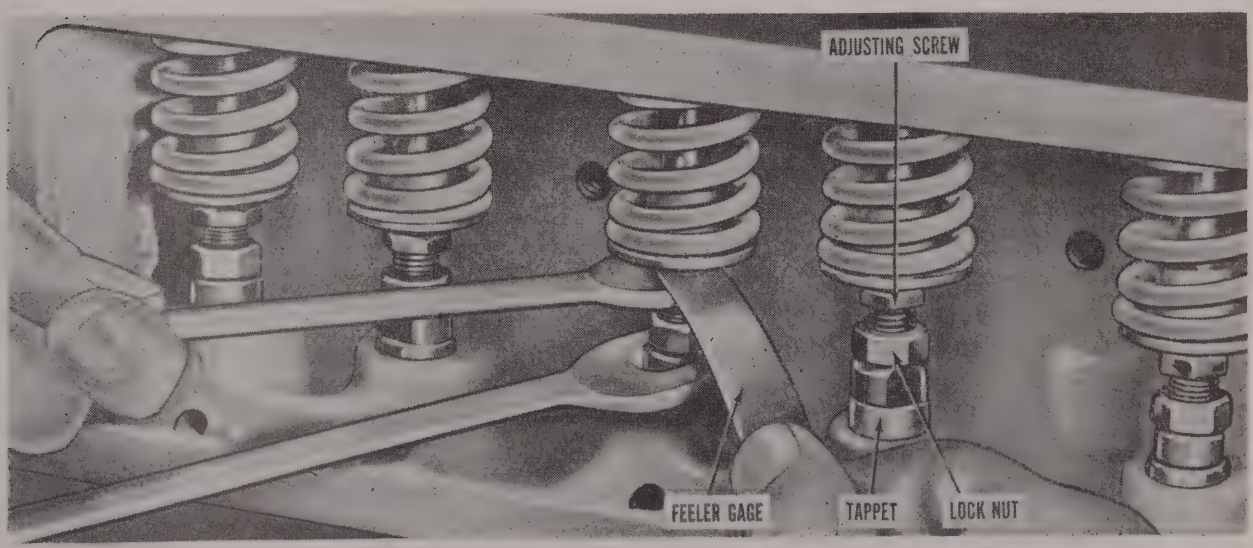


Figure 9. Adjusting valve tappet clearance.

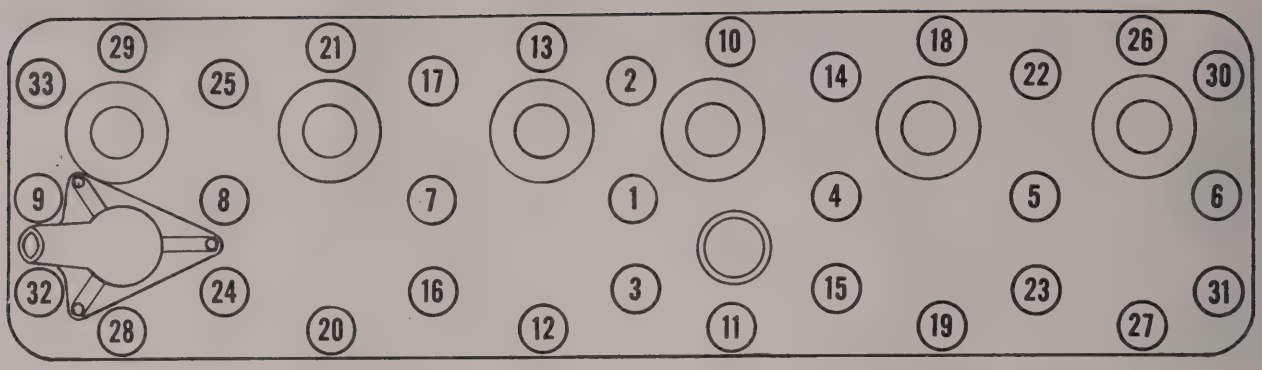


Figure 10. Cylinder head tightening sequence.

(4) Check vacuum gage. Reading should be 18 to 22 inches and needle should hold steady or have slight flutter. If needle does not indicate desired reading, adjust idle mixture screw to obtain highest steady reading by turning screw clockwise until it is lightly seated; then back off until proper reading is obtained.

(5) If vacuum gage needle cannot be held steady after these carburetor adjustments have been made, it will be necessary to make a detailed inspection of the fuel and ignition systems as it may be necessary to replace the distributor, carburetor, or to adjust engine timing.

27. Oil Filter

Monthly, or every 100 operating hours, when crankcase oil is changed, remove oil filter cover and lift out element. Remove drain plug at bottom of filter and drain off excess oil and sludge. Wash filter in dry cleaning solvent. Install new element and replace drain plug. Inspect top gasket; replace if necessary. Install cover and tighten retaining screw securely. Run engine until warm; check filter for leakage.

28. Air Cleaner

a. Maintenance. Check oil level and clean assembly monthly. Clean more often than usual if operating in an area filled with dust, chaff, or lint. Never remove filter element while engine is running. Never run engine without air cleaner in place and oil reservoir filled to indicated level with seasonal engine oil (OE).

b. Cleaning.

(1) Remove three bolts that secure air cleaner extension tube to support on seat frame.

(2) Remove end of extension tube from top of carburetor air horn; remove air cleaner assembly.

(3) Loosen clamp screw at base of air cleaner and remove extension tube from air cleaner.

(4) Unscrew wing nut that holds air filter to oil cup; remove filter.

(5) Empty oil from reservoir and wash reservoir thoroughly in dry cleaning solvent. Move the element up and down in dry cleaning solvent to loosen and wash out any dirt or sludge formation. Blow out air cleaner extension tube with air hose.

(6) Fill oil reservoir to indicated level with engine oil (OE).

(7) Replace element and cup; secure with wing nut.

(8) Install extension tube on air cleaner and tighten clamp screw securely.

(9) Install remaining end of extension tube on top of carburetor air horn.

(10) Mount air cleaner extension tube to support on seat frame; tighten three mounting bolts securely.

29. Fuel Pump

Loosen holddown clamp screw and move holddown clamp and seat to one side. Remove sediment bowl, gasket, and screen. Clean bowl and screen thoroughly in dry cleaning solvent; blow out bowl and screen with air hose, making sure that screen is free of all dirt or other foreign particles. Position screen, new gasket, and sediment bowl to pump. Move holddown clamp into place beneath sediment bowl; pull clamp screw seat up against bowl base opening and tighten jam nut against seat until bowl is secure against gasket.

30. Clutch Pedal Adjustment

Adjust the clutch pedal to have a three-fourths-inch free travel to compensate for lining wear. Depress the clutch pedal by hand; measure the distance the pedal travels before resistance is felt; adjust as follows:

a. Remove the clutch-pedal-to-release-arm-rod clevis pin.

b. Rotate the clevis on its threads until the proper adjustment is obtained.

c. Install clevis pin and secure with cotter pin.

d. If clutch continues to slip or grab after pedal free travel adjustment, report to designated individual in authority.

31. Radiator

a. Maintenance.

(1) Check water level daily. Do not overfill. Fill radiator until level reaches lower edge of baffle.

(2) Check antifreeze protection during cold weather. Warm engine to operating temperature before testing. Fill and empty tester several times to warm it before taking readings. Keep tester clean inside and out.

(3) Drain, flush, and refill whenever inspection reveals accumulation of rust or scale. Clean seasonally as well as before and after using antifreeze solution.

(4) If engine overheats due to lack of water, do not add cool water immediately. Let engine cool; then start engine and add water slowly to avoid sudden changes in temperature that might damage cylinder block and head.

b. Draining and Refilling.

(1) Open drain cock at the bottom of radiator and auxiliary drain cock at right side of engine block. If coolant solution is to be saved, drain into a clean container. If radiator is not to be refilled immediately, attach a tag to steering handwheel warning personnel that the radiator has been drained.

(2) Close drain cocks and refill. Use clean water, preferably soft water free of alkali or other irritants likely to cause rust or scale. Fill through radiator filler pipe until level reaches lower edge of baffle, visible through filler hole. Install radiator cap and turn clockwise to tighten and lock. Operate engine until warm; check water level in radiator and add more if required.

c. Cleaning and Flushing.

(1) Operate engine at moderate speed to agitate loose rust or other impediments in cooling system.

(2) Drain cooling system.

(3) Close drain cocks and fill system with specified cleaning compound.

(4) Install radiator cap.

(5) Operate engine until solution has had ample time to circulate through cooling system after the solution has become warm.

(6) Stop engine and drain system completely by opening both drain cocks.

d. Pressure Flushing. If an overheated condition develops and it cannot be corrected by the above method, the pressure flushing method must be used. Pressure flushing reverses the direction of coolant flow in the cooling system and removes sediment usually not moved by normal flow of the coolant. Before flushing by pressure, be sure to remove thermostat and tighten cylinder head down to prevent possible coolant leak into cylinders.

(1) Drain cooling system.

(2) Remove fan.

(3) Remove engine hose.

(4) Install pressure gun (one using air pressure to impel water) to engine outlet elbow and force water through block until water expelled from block runs clear.

e. Exhaust Gas Leakage Test. Perform the exhaust gas leakage test to determine whether gas is entering the cooling system as the result of a leaky cylinder head gasket, cylinder head, or cylinder block. Make the test with the engine cold.

(1) Remove the fan belt and open radiator drain cock until water is below cylinder head water outlet.

(2) Loosen screws that hold water outlet elbow; remove elbow; and fill head with water until level has reached top of head.

(3) Start engine; accelerate it several times; and watch for bubbles in water. Appearance of bubbles indicates leakage that must be corrected. Report condition to designated person in authority.

32. Fan and Fan Belt

Loosen cap screws in vertical slots of fan frame. Move fan frame up or down to loosen or tighten fan belt to approximate deflection desired; tighten screws just enough to support fan frame and test fan belt for finger-pressure deflection of one-half inch. If deflection is correct, tighten fan frame mounting cap screws all the way in; if the deflection is not correct, repeat procedure above until proper belt deflection is obtained.

33. Thermostat

Remove outlet hose from outlet elbow and remove elbow and thermostat as a unit. Drain coolant until coolant level is below cylinder head. Remove thermostat from outlet elbow and inspect the bellows and valve; the valve should be closed at room temperature. Immerse the thermostat in a heated pan of water. Raise the temperature of the water (check with thermometer) to the range in which the thermostat functions. If the thermostat does not open within the limits for which it is designed (165° to 185° F.), it should be replaced.

34. Battery

a. Maintenance. Recharge the battery, if temperatures are normal, when the specific gravity reading is 1.175 or lower. It is fully charged when the specific gravity reading is 1.275 to 1.285. Fill with clean distilled water to a point one-half inch above plates. Clean with ammonia and coat terminals with petroleum jelly.

b. Capacity Test.

(1) Take hydrometer gravity reading of battery.
(2) Connect a test voltmeter positive wire lead to positive terminal of battery and voltmeter negative wire to battery negative terminal.
(3) If no current is being drawn from battery, voltage reading should be 6 to 8 volts.
(4) Recharge battery if hydrometer reading or voltmeter reading is low.

c. Voltage Drop Test. The voltage drop test is used to determine the amount of energy lost while current is being conducted from the battery to various units of the electrical system. A test voltmeter should be connected between the battery and the unit to be tested, and the test accomplished as follows:

(1) Connect voltmeter leads to battery terminals.
(2) Turn off ignition switch and crank engine by pressing starter button.
(3) Record voltmeter reading.
(4) Connect voltmeter between ground on engine and starter switch.
(5) Press starter button and crank engine with ignition switch off.
(6) Record voltmeter reading.
(7) The difference between first and second readings should not be greater than .25 volt.
(8) The difference between the two readings may be checked by connecting voltmeter between battery terminal and ignition switch terminal on ignition coil. The voltmeter reading, when the engine is cranked by the starter, should be a maximum of .25 volt.

d. Battery Cable and Cable Connection Test.

(1) Connect voltmeter between negative terminal on battery and ground on engine.
(2) Crank engine by pressing starter button.
(3) The voltage drop should not be more than .1 volt.
(4) Reading may be checked by connecting voltmeter between distributor base and distributor terminal on ignition coil. Reading should be a maximum of .1 volt.

35. Distributor

a. Maintenance.

(1) Release clamp and remove distributor cap.
(2) Remove spark plug leads, marking for identification; remove coil lead.
(3) Remove rotor and inspect breaker points. If points are slightly pitted or gray in color, they need not be replaced. Clean with a fine-cut file. Replace rough or badly pitted breaker points.
(4) Check breaker point gap and adjust to have a .024- to .026-inch gap by loosening contact assembly lock screw slightly, loosening contact assembly adjusting lock screw at stationary contact, and inserting screwdriver in adjustment slots to turn contact assembly in desired direction for correct setting (fig. 11).
(5) Inspect distributor cap for cracks, carbon streaks, or corroded terminals. Re-

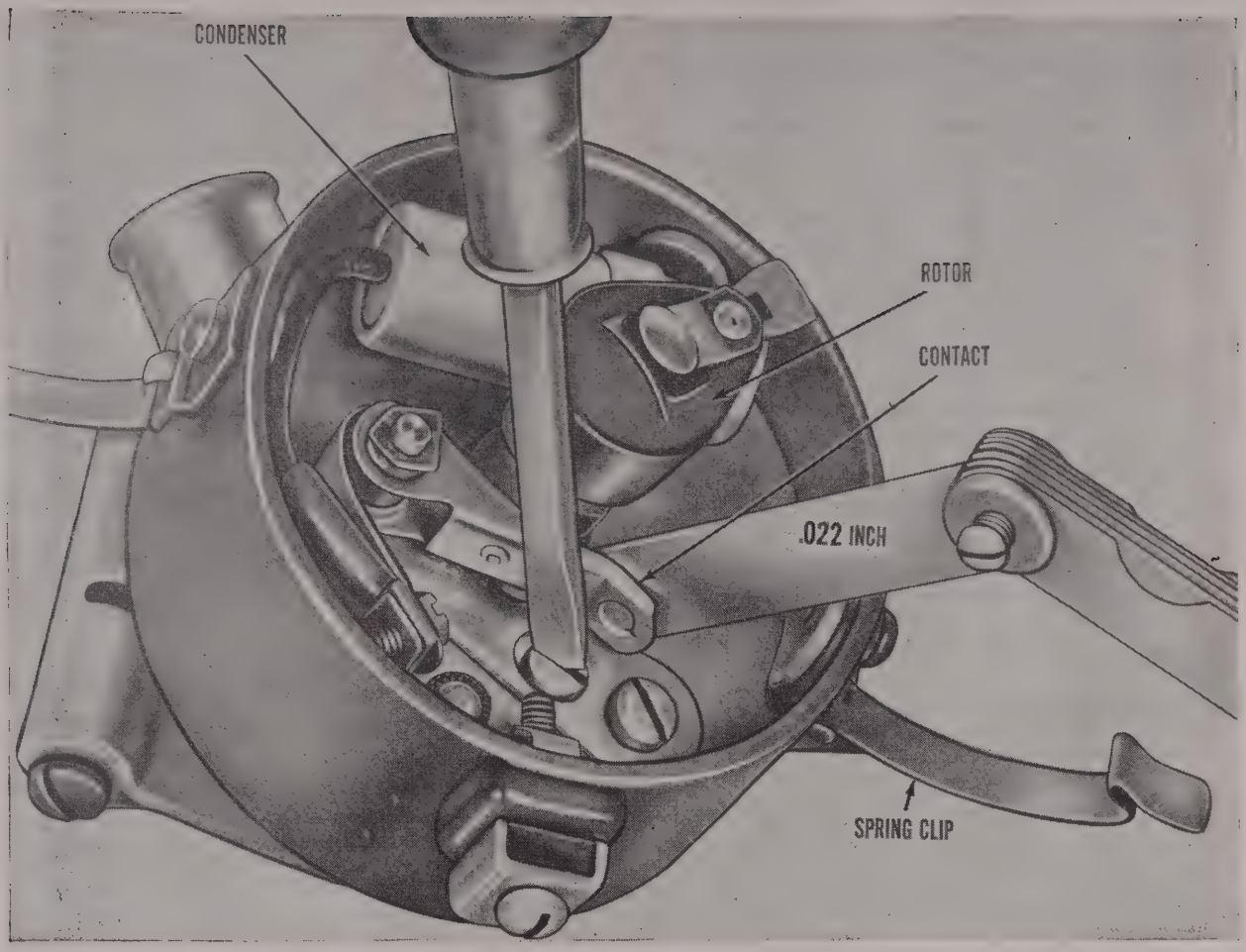


Figure 11. Breaker point adjustment.

place cap if any of these conditions are found.

(6) Inspect metal inserts on inside of cap. After distributor has had normal use, the vertical faces of the inserts become slightly burned. If burning is excessive, replace cap. Do not attempt to file inserts.

(7) Examine inserts for burning of horizontal faces. If burning is obvious at this point, the gap between insert and rotor is too large and the rotor and cap should be replaced.

(8) Inspect rotor for cracks and burns. After normal use, the end of the metal strip will burn to a bluish color. Clean with refined carbon tetrachloride. If top of metal strip is burned, replace rotor and cap.

b. Initial Ignition Timing. Before checking ignition timing, make sure that the distributor breaker contacts are clean, centered on each other, and set to proper gap.

(1) Remove No. 1 spark plug.

(2) Place thumb over No. 1 spark plug hole and crank engine with starter until rising piston forces air out around the thumb.

(3) Aline timing marks on crankshaft power take-off pulley with stationary pointer on timing gear cover. At this point the distributor points should start to open. If they do not, it may be necessary to rotate distributor body approximately 15° clockwise, and then slowly rotate the body counterclockwise until the contacts start to open.

(4) Tighten the distributor lock screw; start the engine and check the timing with the aid of a timing light.

c. Timing Light Check.

(1) Disconnect distributor vacuum line.

(2) Reinstall No. 1 spark plug; connect the

timing light to the engine with the high tension lead on No. 1 spark plug and the other two leads to the battery terminals.

(3) Clean dirt and grease from timing marks and cover the timing mark and pointer with white chalk.

(4) Start the engine and operate it at normal speed. Direct the light on the timing mark; it should flash just as the timing mark is in line with the pointer if the timing is correct. The operator should stand so that his line of vision is in line with the center of the power take-off pulley and the pointer.

(5) If the timing mark on the pulley and the pointer do not line up, rotate the distributor until they are in line. To advance the timing, rotate the distributor body counterclockwise and to retard the timing, rotate the distributor body clockwise.

36. Service Brakes

a. Maintenance.

(1) Examine brake fluid supply in master cylinder, periodically. Fill master cylinder to proper level, if necessary, whenever inspection is made.

(2) Keep wheel bearings and brakes properly adjusted.

(3) Keep all brake hydraulic line fittings tight and leakproof.

(4) Replace scored brake drums or saturated brake linings.

(5) Clean brake drums regularly.

(6) Keep lever eccentric pin lock nut tight; keep brake backing plate stud nuts tight.

(7) Adjust the brake pedal to ⅛- to ¼-inch free travel to assure full release of brakes.

(8) Inspect brake control linkage periodically for freedom of operation.

b. Brake Shoe Adjustment. Adjustment may be made with the crane resting on jacks or on the floor. On jacks, brake drag is checked by rotating the drive wheel forward when adjusting the forward shoe and backward when adjusting the reverse shoe. On the floor or road, brake drag is checked by tapping the drum with hammer or wrench to determine whether linings are dragging on the drum. Sound is deadened when linings contact the drum.

(1) Make all adjustments with the drums cool.

(2) Release hand brake lever and loosen hand brake cables.

(3) Place a wrench on cam and shoe guide stud to adjust the forward shoe. Rotate the wrench in the forward direction of wheel rotation to decrease lining-to-drum clearance. Reduce the clearance until the lining drags on the drum.

(4) Move the wrench slightly in the reverse direction until the drag is relieved.

(5) Place the wrench on the cam and shoe guide to adjust the reverse shoe. Rotate the wrench in the opposite (reverse) direction of drum rotation, decreasing the clearance until the lining drags.

(6) Turn the wrench slightly in the opposite (forward) direction until the drag is relieved.

(7) Connect hand brake cables and adjust to proper tension by turning hand brake lever handle to increase or decrease tension on cables.

c. Bleeding Brakes. Effective operation of the hydraulic system depends on a solid flow of fluid (without air bubbles) to all points in the pressure system. When air bubbles are mixed with the fluid, the brakes must be bled to remove them. The need for bleeding is indicated when the brake pedal has a spongy action when applied.

(1) Make certain that brake master cylinder is filled to proper level.

(2) Open wheel cylinder bleeder screw one turn on one wheel.

(3) Put bleeder hose over end of screw and submerge the other end in a clean container of brake fluid.

(4) Depress brake pedal slowly and then allow it to return to the released position. Repeat this operation several times. Observe bleeder hose flow for air bubbles.

(5) When air bubbles no longer appear and the stream is solid, close bleeder connection.

(6) Repeat this process on other wheel.

(7) Never re-use the fluid drawn out of the system. Be sure that the linkage between the brake pedal and master cylinder permits at least a ¼- to ½-inch pedal travel before the cylinder in the master cylinder

housing is contacted by the pedal link rod.

37. Sluing Brake Adjustment

a. Adjust cap screw connecting brake throwout yoke to sluing clutch shifter shaft for clearance of one-eighth to three-sixtenths inch between brake clutch cone and stationary clutch half facings. Turn screw clockwise to decrease clearance; counterclockwise to increase clearance.

b. If lining on brake clutch cone is worn beyond serviceable limits and proper adjustment cannot be made, report to designated individual in authority.

38. Winch Brake Adjustment

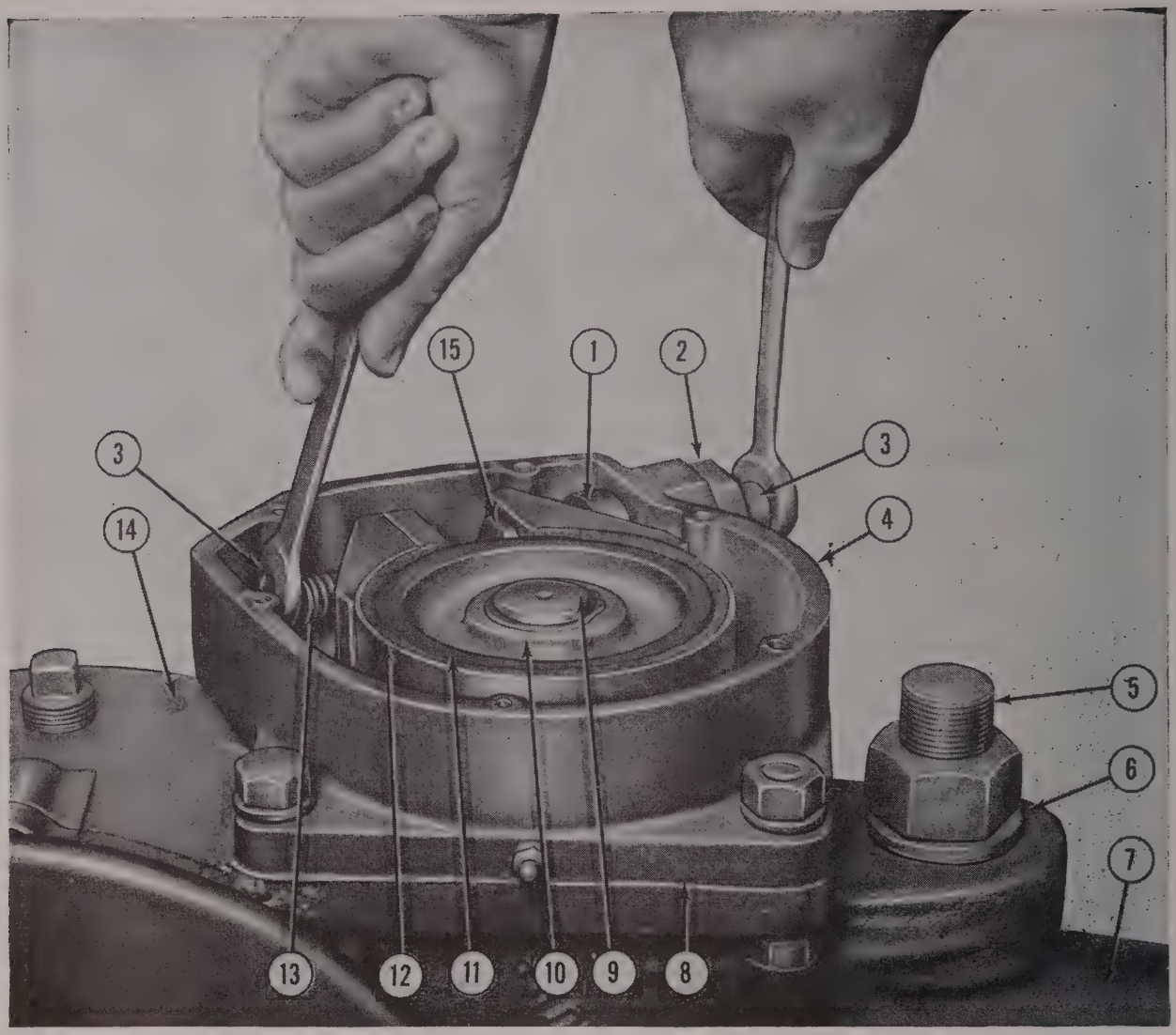
a. Major Adjustment. Rotate linkage arm between brake and winch operating lever to obtain desired adjustment. Adjustment is correct if winch brake band is firmly applied when the winch operating lever is in a neutral position.

b. Minor Adjustment. Clearance between brake band and drum may be adjusted by loosening or tightening adjusting nuts on the brake spring rod (fig. 12). When desired adjustment has been completed, be sure that lock nuts are turned in tight against adjusting nuts to secure adjustment.

39. Sluing and Winch Transmission Clutch Adjustments

a. Sluing Clutch Adjustment. Remove clevis pins and turn sluing shifter shaft to adjust clutch lining to have a $\frac{1}{8}$- to $\frac{3}{16}$-inch clearance.

b. Winch Clutch Adjustment. Remove clevis pins at throwout yokes and turn shifter lever arms in or out for a $\frac{1}{8}$- to $\frac{3}{16}$-inch clearance.



1 Brake band adjusting nut
2 Brake band positioning rod lock nut
3 Brake spring rod adjusting nut
4 Winch brake housing
5 Winch mounting bolt
6 Winch mounting arm
7 Winch frame bracket
8 Winch brake housing mounting flange
9 Winch worm shaft
10 Winch brake drum
11 Winch brake band lining
12 Winch brake band
13 Brake spring rod
14 Winch worm gear housing
15 Brake band keeper

Figure 12. Winch brake adjustment.

CHAPTER 4

FIELD MAINTENANCE

Section I. ENGINE

40. Overall Unit

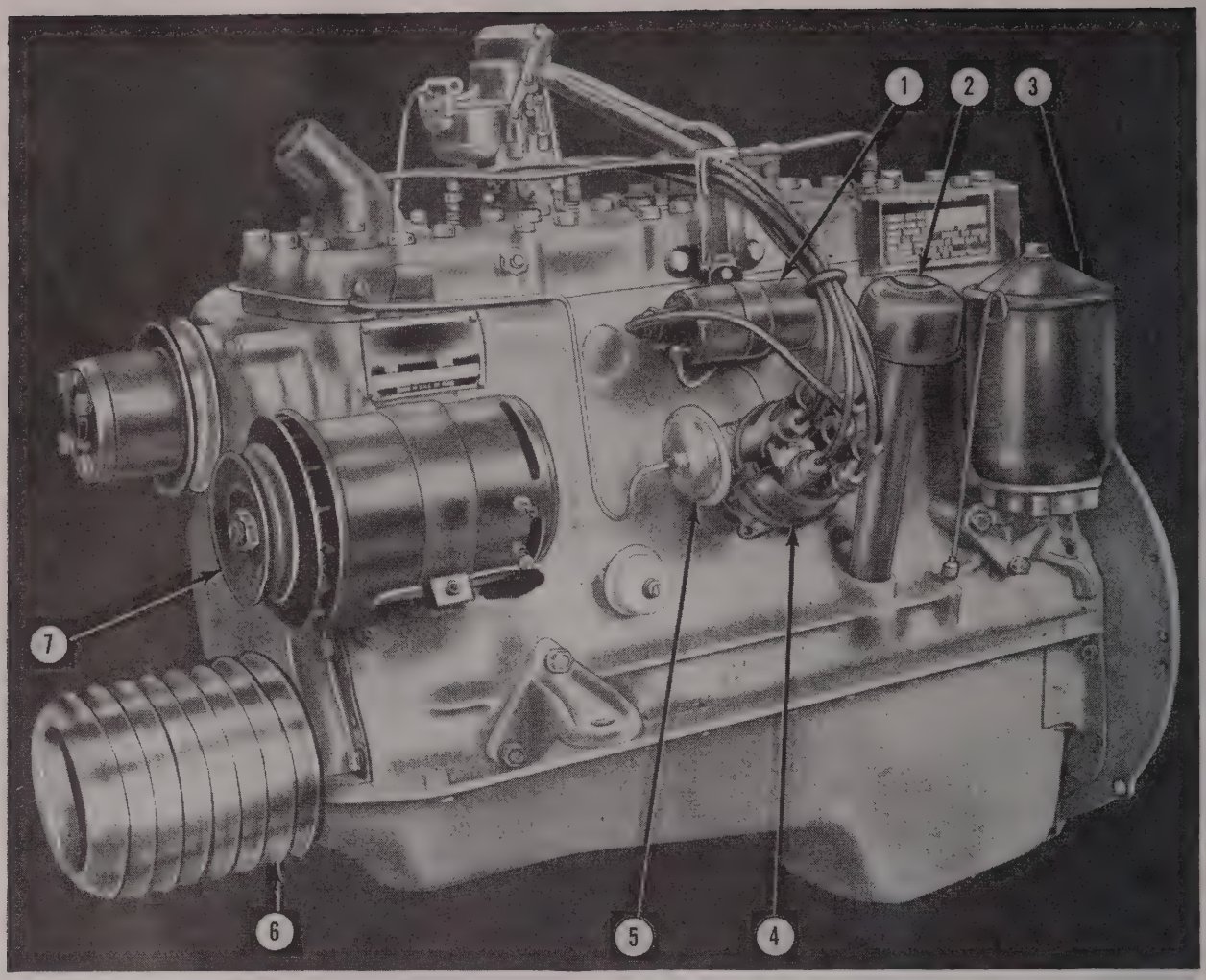
The engine (figs. 13 and 14) is a six-cylinder, in-line, four-cycle, L-head, Ford industrial engine. The cylinder block and upper half of the crankcase are a one-piece casting, and together with the cylinder head comprise the main body of the engine to which all accessory equipment is installed or attached. The four crankshaft (main) bearings are the replaceable-insert precision type.

a. Removal.

(1) Remove seat.
(2) Remove battery cable and remove air cleaner duct at carburetor.
(3) Remove intermediate shaft from steering linkage.
(4) Remove seat frame and radiator mounting supports.
(5) Remove fuel line from tank at fuel pump and block.
(6) Remove generator and water pump drive belts; remove fan drive belt.
(7) Disconnect fuel gage wire at tank unit.
(8) Remove radiator hose clamps at top and bottom.
(9) Remove three cap screws that secure seat frame and radiator grille mounting supports to frame. Remove seat frame and radiator grille as a unit.
(10) Separate engine electrical system leads at plastic tube junctions.
(11) Loosen four bolts at each side power take-off pulley; loosen adjusting screws and remove pulley drive belts.
(12) Loosen three cap screws on sluing drive power take-off pulley mounting bracket and move bracket to loosen drive belt. Remove drive belt.
(13) Disconnect wiring at voltage regulator.
(14) Disconnect muffler down pipe at exhaust manifold.
(15) Disconnect choke, throttle, and accelerator linkage.
(16) Remove shift levers from caps on transmission case.
(17) Disconnect wiring harness from starter solenoid to engine.
(18) Disconnect cable between solenoid and starting motor.
(19) Remove two cap screws from transmission mounting bracket.
(20) Remove bolts from engine mounts.
(21) Place an assistant beneath the crane to guide the propeller shaft differential input shaft slip joint from engagement (fig. 15) and move the engine to the rear. Alternate method for disconnecting propeller shaft is to remove four bolts and screws from differential input shaft slip joint companion flange and allow the slip joint to remain on the input shaft when the engine is removed.
(22) Check to see that engine is free of all connections to crane or assemblies. Remove engine, clutch, and transmission from crane as a unit (fig. 16), using suitable chain hoist.

b. Installation.

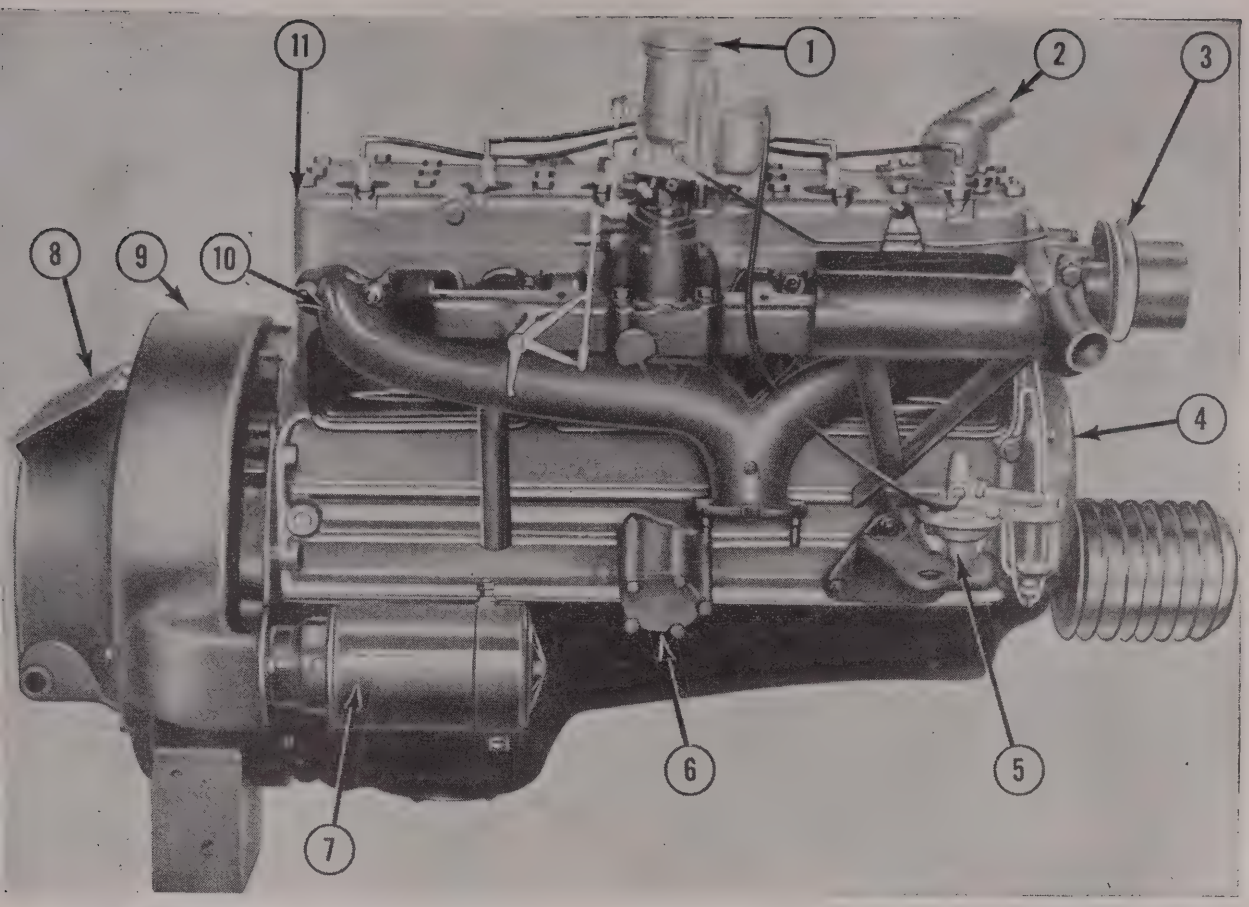
(1) Lower engine and transmission into crane frame and position engine so that assistant may install propeller shaft slip joint on differential input shaft splines. If alternate method of disconnecting propeller shaft from differential has been used, lower engine until assistant may bring the propeller shaft and slip joint companion flanges into line and install four connecting bolts and nuts.



1 Ignition coil
2 Oil filter pipe
3 Oil filter
4 Distributor
5 Diaphragm
6 Crankshaft pulley
7 Generator

Figure 13. Engine—right side view.

(2) Install bolts in engine mounts and tighten securely; install two cap screws in transmission mounting bracket and tighten securely.
(3) Connect cable between solenoid and starting motor and connect wiring harness from starter solenoid to engine.
(4) Install shifting levers in caps.
(5) Connect choke, throttle, and accelerator linkage.
(6) Install muffler down pipe to exhaust manifold, using new gasket.
(7) Connect wiring to voltage regulator.
(8) Install sluing drive power take-off pulley drive belt and move pulley bracket to adjust drive belt to proper deflection. Tighten bracket mounting cap screws securely.
(9) Place belts over side power take-off and main power take-off pulleys and adjust side power take-off pulley mounting brackets to place belts in tension. After belts are in tension, tighten pulley bracket cap screws securely. Complete drive belt adjustment by turning adjusting screws at each side power take-off pulley until drive belts have been adjusted to have a ½-inch finger-pressure deflection.
(10) Connect all wires to plastic junctions. Check color of each wire to see that it is the same color as the wire in opposite end of each plastic junction.



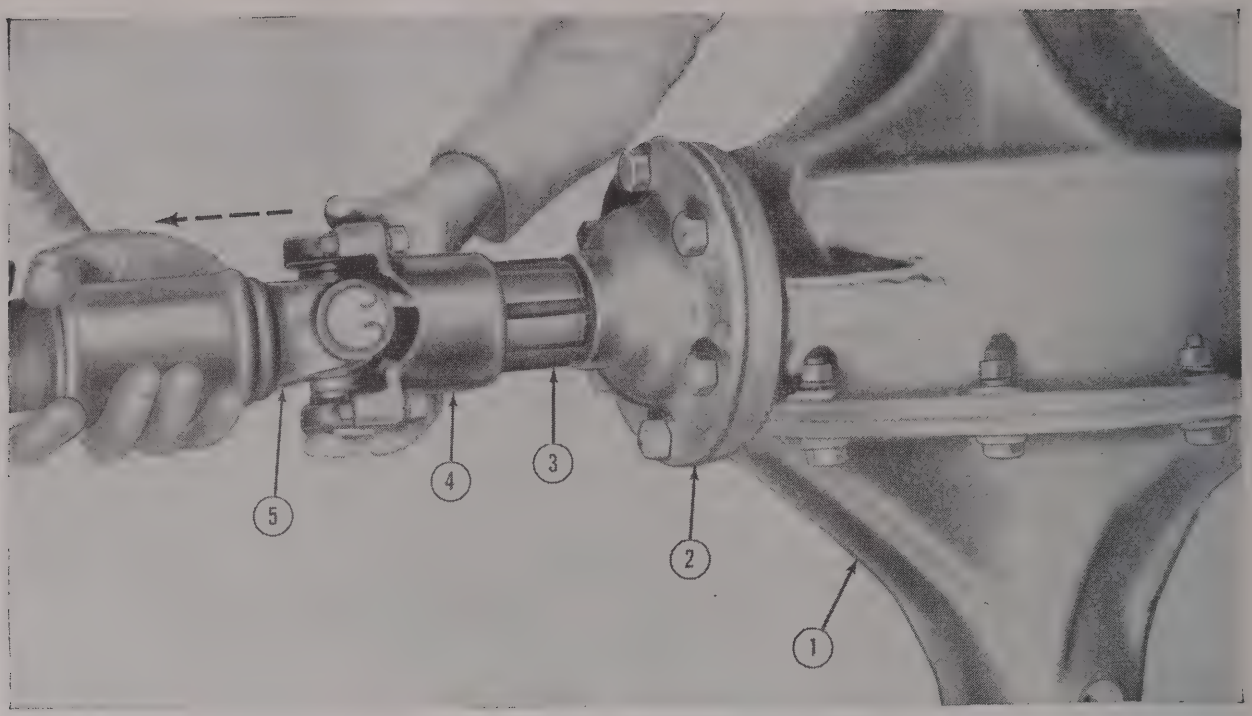
1	Carburetor	4	Water pump	7	Starting motor	10	Manifold
2	Water outlet	5	Fuel pump	8	Clutch housing	11	Cylinder head
3	Water pump	6	Oil pump	9	Flywheel housing		

Figure 14. Engine—left side view.

(11) Position seat frame and radiator grille. Install three cap screws in each side securing seat frame and radiator grille mounting supports to frame; tighten securely.
(12) Install radiator hose clamps, top and bottom, and tighten clamp screws until connection is fast.
(13) Connect fuel gage wire to tank unit.
(14) Install generator and water pump drive belts; install fan drive belt. Adjust to proper deflection.
(15) Unblock fuel line from tank and install on fuel pump. Tighten to make snug connection.
(16) Install air cleaner duct at carburetor.
(17) Install intermediate shaft on steering linkage.
(18) Install battery cable.
(19) Install seat.
(20) Operate engine and adjust linkage to carburetor, if necessary. Test steering and adjust linkage, if necessary.

41. Intake and Exhaust Manifold

a. Removal.
(1) Remove air cleaner duct from carburetor.
(2) Disconnect distributor vacuum line, choke wire, and fuel line at carburetor.
(3) Disconnect governor lines.
(4) Disconnect accelerator linkage at carburetor.
(5) Remove carburetor and governor.
(6) Remove the screw that holds manifold air baffle assembly to cylinder head.
(7) Remove the intake manifold baffle assembly.
(8) Disconnect muffler inlet pipe from the exhaust manifold.
(9) Remove manifold holddown nuts and re-



1 Differential housing
2 Differential drive pinion adapter flange
3 Differential drive pinion
4 Splined input shaft yoke
5 Propeller shaft yoke

Figure 15. Removing propeller shaft from differential.

move manifold assembly and gaskets from the engine block.

b. Installation.

(1) Position the manifold assembly on the block, using new gaskets.
(2) Install and tighten holddown nuts to 25 to 30 pound-feet torque. Start at the center and work toward the ends to avoid manifold distortion.
(3) Install carburetor and governor, using new gaskets.
(4) Connect accelerator linkage, choke wire, fuel line, and distributor vacuum line to carburetor.
(5) Install manifold air baffle assembly to cylinder head; tighten holding screw securely.
(6) Install air cleaner duct to carburetor.
(7) Install muffler inlet pipe to exhaust manifold, using new gasket. Tighten cap screws securely.

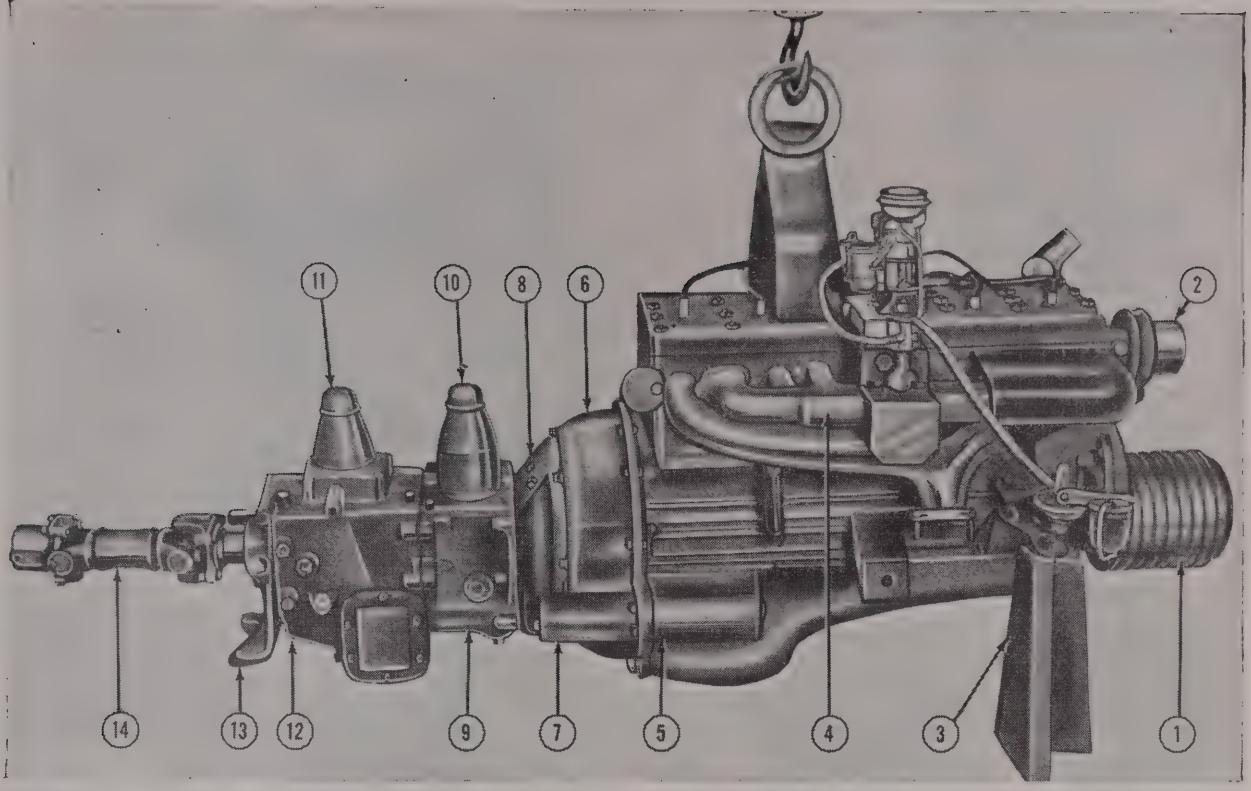
42. Cylinder Head

a. Removal.

(1) Tilt seat back.
(2) Disconnect upper and lower radiator hoses from water pump and outlet casting.
(3) Remove cylinder head outlet casting and thermostat.
(4) Unhook coil primary wire at coil.
(5) Remove distributor housing cap from distributor; remove spark plug leads.
(6) Remove distributor advance line.
(7) Remove spark plugs; make sure that this is done before removing cylinder head cap screws.
(8) Loosen cylinder head cap screws.
(9) Lift cylinder head and coil from block. If cylinder head is stuck on block, install spark plugs and crank engine a few revolutions to separate head from gasket.

b. Installation.

(1) Make sure that gasket surfaces of both block and cylinder head are clean and smooth.
(2) Install new head gasket, making sure that holes in gasket are in proper alinement with coolant passages at flywheel end of engine.
(3) Coat threaded ends of cylinder head cap screws with sealing compound to prevent



1 Main power take-off pulley
2 Water pump
3 Engine mount
4 Manifold assembly
5 Starter motor
6 Clutch and flywheel bell housing
7 Starter motor drive
8 Clutch inspection plate
9 Forward-reverse transmission
10 Forward-reverse shift lever tower casting
11 Four-speed transmission shift lever tower casting
12 Four-speed transmission
13 Transmission mounting bracket
14 Differential propeller shaft

Figure 16. Removing power train from crane.

coolant leak at thread. Failure to use sealing compound may result in coolant leak into cylinder and possible hydraulic lock.

(4) Position cylinder head on block and insert and finger-tighten several cap screws to hold head in position. Insert remainder of cap screws and tighten all cap screws slightly and evenly.

(5) Tighten cap screws to 65 to 70 pound-feet torque, following sequence indicated in figure 10.

(6) Install cleaned and regapped or new spark plugs; tighten spark plugs to 26 to 30 pound-feet torque; install spark plug leads.

(7) Connect primary lead to coil. Distributor lead must be connected to PLUS coil terminal to assure maximum ignition point service life.

(8) Install cylinder head outlet casting and upper radiator hose; apply thin coating of sealing compound to hose before installation. Tighten holddown clamp securely.

(9) Install thermostat.

(10) Install lower radiator hose and tighten holddown clamp securely.

(11) Operate engine to normal operating temperature (150° to 180° F.); shut off engine; allow to cool; retighten cylinder head cap screws.

43. Oil Filter

a. Removal. Remove the three retaining cap screws and remove the oil filter from the engine block.

b. Installation. Using new gasket, install oil filter on block. Tighten cap screws securely.

44. Oil Pressure Relief Valve

a. Removal. Refer to figure 17 and proceed as follows:

(1) Remove spring and plunger retaining plug from block.
(2) Remove spring and plunger.

b. Installation.

(1) Insert plunger in spring, using new retainer plug gasket.
(2) Install retainer plug and tighten securely.

45. Oil Pan

a. Removal.

(1) Drain crankcase.
(2) Remove splash pan.
(3) Disconnect starter cable and remove starter.
(4) Disconnect ventilation pipe bracket.
(5) Remove screws that hold oil pan to engine rear plate.
(6) Remove screws that hold oil pan to engine block and front cover plate.
(7) Remove oil pan from engine.
(8) Remove cap screws that hold oil pump screen bracket to main bearing cap.
(9) Remove cap screws that hold oil pump screen tube to block and remove oil pump screen assembly.

b. Oil Seal Replacement.

(1) Remove the oil packing and thoroughly clean the packing retainer grooves.
(2) Soak the packing in engine oil (OE) for 2 hours before installation.
(3) Install the short packing in the front retainer groove and the long packing in the rear retainer groove.
(4) Roll in the packing with a round bar to make sure the packing meets the gasket evenly.

c. Installation.

(1) Connect oil pump screen assembly to cylinder block, using a new gasket.
(2) Position new oil pan gasket on oil pan and tie with soft thin thread at each end at middle.
(3) Secure oil pump screen bracket to main bearing cap.
(4) Position oil pan under engine, then raise to cylinder block.
(5) Insert all oil-pan-to-block cap screws in place except starter front support bracket

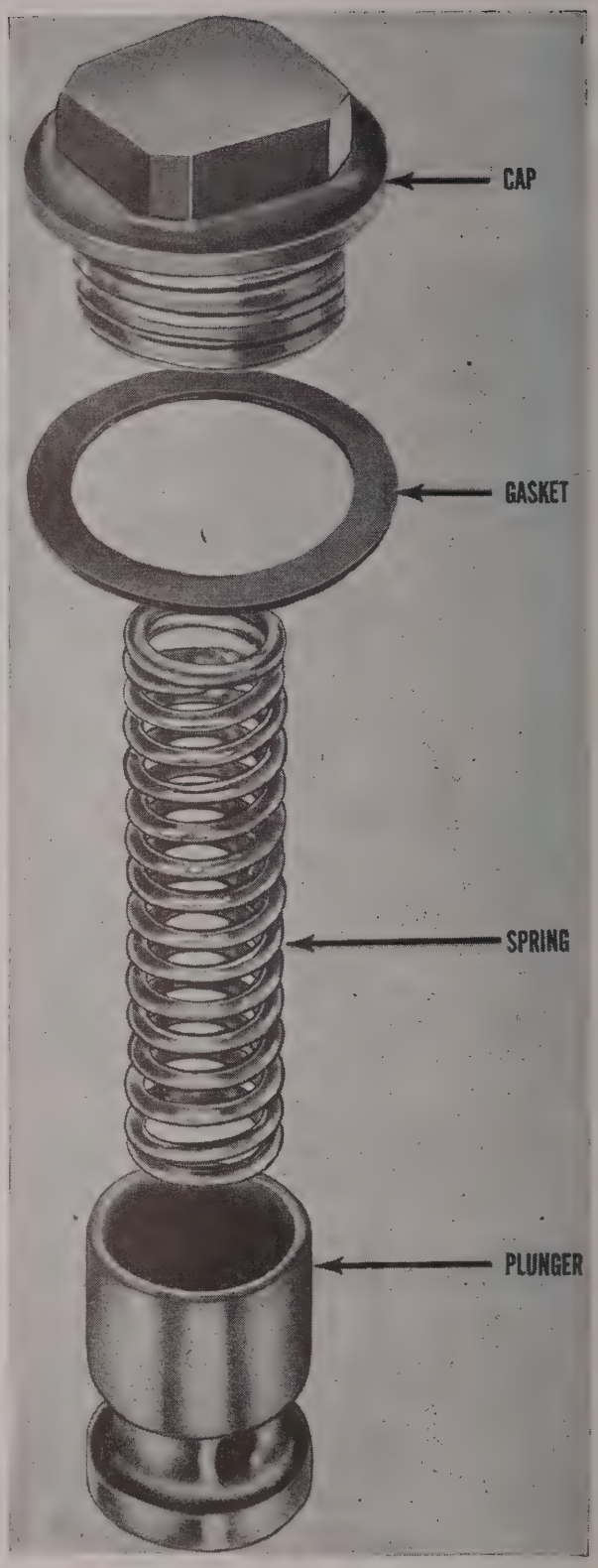


Figure 17. Oil pressure relief valve.

cap screw. Tighten cap screws to move pan up against block, leaving pan loose enough to move forward and backward.

(6) If clutch and clutch disk are to be installed at this time, do so, making sure clutch pilot bearing is properly lubricated.

(7) Attach flywheel housing to rear engine plate and block and tighten securely.

(8) Draw oil pan back against rear engine plate by inserting the two 7/16-inch cap screws through flywheel housing and rear engine plate into the tapping block holes in the oil pan and the two lower 5/16-inch cap screws through the oil pan rear flange to the rear engine plate. Tighten cap screws so that oil pan is back against rear engine plate, but loose enough for pan to move.

(9) Tighten oil pan bolts in block to 10 to 15 foot-pounds torque.

(10) Install two upper 5/16-inch cap screws through the oil pan rear flange to the rear engine plate and tighten four 5/16-inch cap screws from oil pan to rear engine plate and two 7/16-inch cap screws from flywheel housing to oil pan tapping block.

(11) If starter is to be installed at this time, assemble starter to rear engine plate, installing starter front support bracket bolt through oil pan to block and tighten securely.

46. Oil Pump

The rotor type oil pump is externally mounted and is driven from the camshaft by the same gear that drives the distributor. Before removing the oil pump, check the backlash between the oil pump driven gear and the camshaft gear. To do this, move the distributor rotor and check distributor shaft free play which should be less than one-fourth of an inch at tip of rotor. A schematic diagram of the engine lubrication system, with the oil pump out of position for photographic purposes, appears as figure 18.

a. Removal. Remove three retaining cap screws and withdraw pump from engine.

b. Installation. Fill pump with clean oil and turn gear by hand to wash out foreign particles. Position new gasket on pump and install pump in engine. Tighten cap screws to a 10 to 15 pound-feet torque.

47. Valves

a. Removal.

(1) Remove cylinder head and manifolds.

(2) Remove valve chamber covers.

(3) Crank engine until tappet rests on heel of cam.

(4) Compress valve spring (fig. 19) and remove valve spring retainer locks.

(5) Remove valve, valve spring, and valve spring retainer.

b. Installation.

(1) Cover oil holes in bottom of valve chamber to prevent keys or other parts from falling into engine.

(2) Turn crankshaft so that tappet is at low side of cam.

(3) Install valve spring in retainer.

(4) Install valve.

(5) Compress spring and install valve spring retainer locks.

(6) Remove cover from oil holes. Adjust valves for proper clearance (par. 26*d*(4)).

(7) Install valve chamber covers, manifolds, and cylinder head.

48. Pistons and Connecting Rods

The solid-skirt aluminum pistons are fitted with four rings all above the full-floating piston pins. Pistons and pins are splash-lubricated. Connecting rod bearings are of the replaceable-insert precision type.

a. Removal. The pistons and connecting rods may be removed from the engine by removing the oil pan and cylinder head, removing the connecting rod bearing caps, and pushing the pistons and connecting rods out through the top of the cylinder block as described in paragraph 108*a*. The pistons and connecting rods should be removed by field maintenance personnel only when engine performance requires inspection of these assemblies to determine the necessity for major engine overhaul.

b. Inspection.

(1) Inspect the pistons, piston rings, piston pins, cylinder bores, and connecting rods to the limit of available measuring devices (par. 108*d*). If inspection indicates that engine performance can be restored by the installation of new stand-

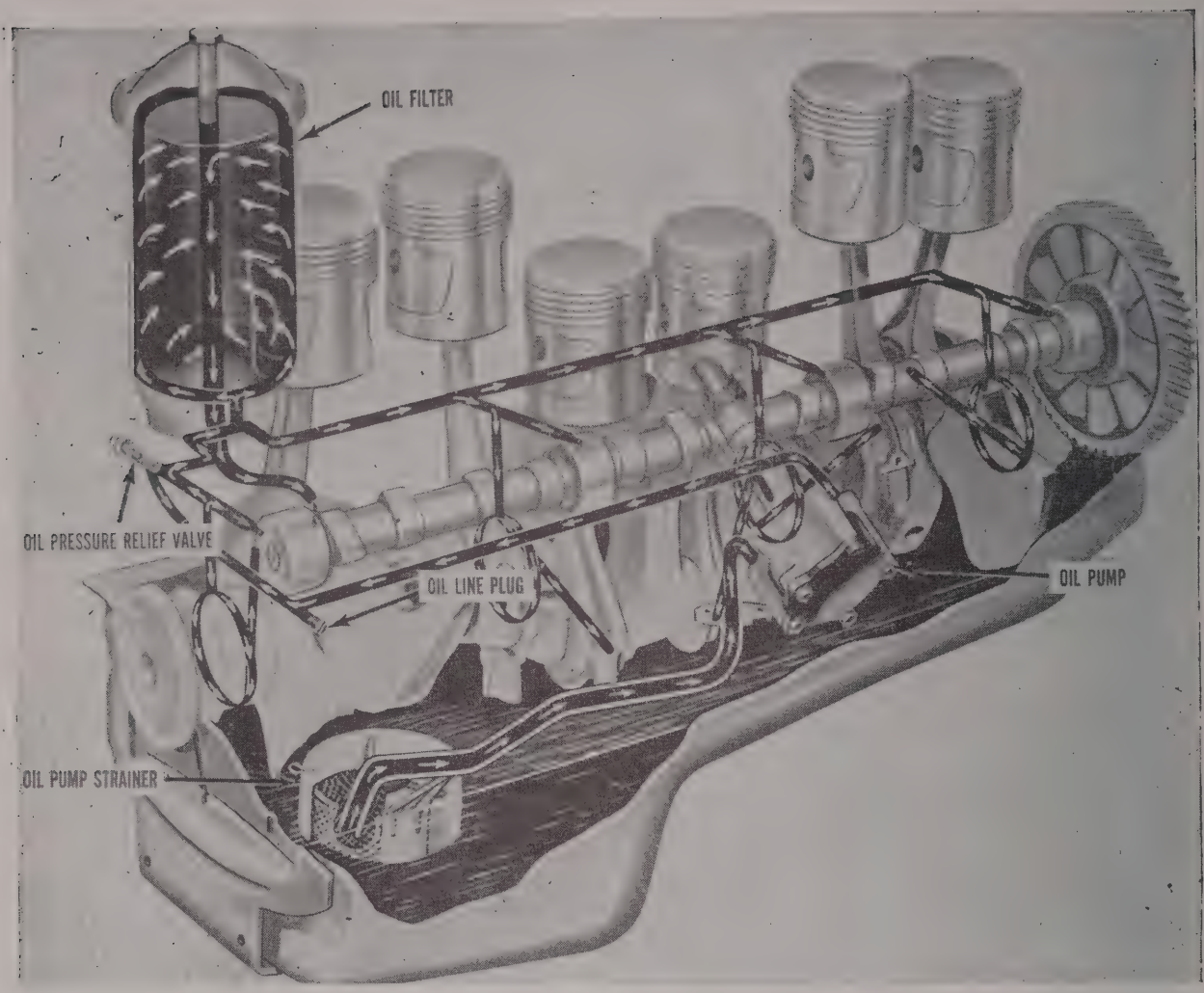


Figure 18. Engine lubrication system—schematic view.

ard rings, install them, making certain that the cylinder bores are properly treated and that the rings are properly fitted as described in paragraph 108*f*. Standard expander-type rings and standard oil control-type rings, also used in unrebored cylinders, may be installed if available.

(2) Reboring cylinders, installation of oversize pistons and rings, replacement of piston pins, and replacement or reconditioning of connecting rod bushings are normally depot maintenance responsibilities. They should not be performed by field maintenance personnel unless proper tools, fixtures, and gages are available.

c. Installation. If possible, use an alining fixture to check pistons and connecting rods prior to installation. See that rings are properly installed on pistons and that pistons are properly installed on connecting rods. Install pistons and connecting rods in cylinder block, using procedures contained in paragraph 108*j* as a guide. Install cylinder head and oil pan.

Section II. FUEL SYSTEM

49. Carburetor

The carburetor is the down-draft, single-venturi type, with an accelerator pump and an economizer device. It is located on the left side of the engine above the governor, and regulates the rate of flow in the fuel system (fig. 20). Main channels are in a removable nozzle bar which contains the idle tube and aspirating (air bleed plug)

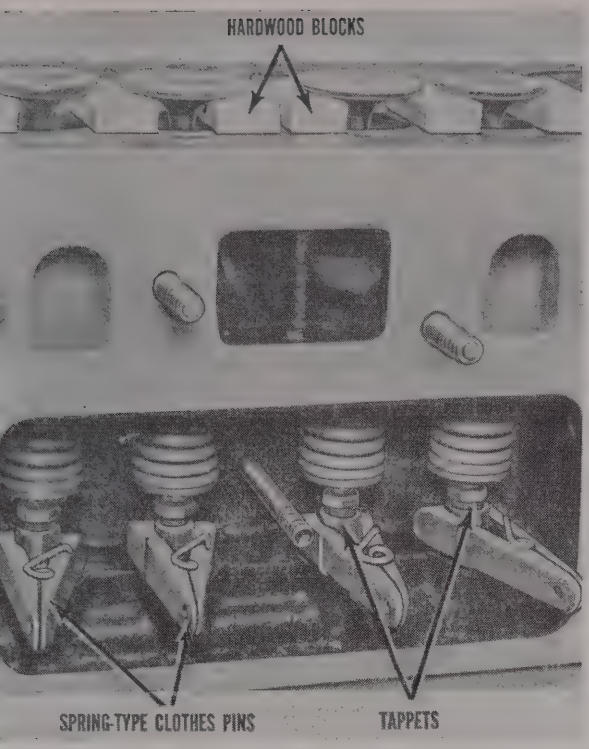


Figure 19. Removing valves.

nozzle. Two adjusting screws are provided, one of which controls the idle air-fuel mixture and the other the speed at which it is delivered, for high or low speeds. Accelerating pump linkage provides three settings for adjusting carburetor to varying climate temperatures.

a. Removal.

(1) Remove air cleaner tube.
(2) Remove choke and throttle controls at carburetor.
(3) Disconnect fuel line at carburetor.
(4) Disconnect vacuum line to distributor at carburetor.
(5) Disconnect carburetor-to-governor line at carburetor.
(6) Remove two nuts from studs that secure carburetor to governor.
(7) Remove carburetor and gasket.

b. Float Level Setting for Closed Position.

(1) Hold air horn, less gasket, upside down with float and fuel inlet needle in closed position.
(2) Using proper gage, check dimension from flange of air horn to bottom side of float (not soldered seam). Dimension should be 1.322 to 1.353 inches.
(3) Bend arm to or from air horn to obtain proper level. Bending arm toward air horn lowers fuel level; bending arm away from air horn raises fuel level.

c. Float Level Setting for Open Position.

(1) Hold air horn, less gasket, right side up with float in full open position.
(2) Check dimension from air horn flange to bottom of float using proper gage. This dimension should be 1.53 to 1.56 inches.
(3) Bend arm to or from needle valve body to obtain proper open position. Bending arm toward valve body raises float open position; bending arm away from needle valve body lowers float open position.

d. Installation.

(1) Place new gaskets over studs; install carburetor on studs and secure with castellated nuts.
(2) Connect carburetor-to-governor line to carburetor. Make tight connection.
(3) Connect distributor vacuum line to carburetor and tighten securely.
(4) Connect fuel line to carburetor and tighten flare nut until snug against fitting.
(5) Connect choke and throttle linkage.
(6) Start engine and test operation.

50. Fuel Pump

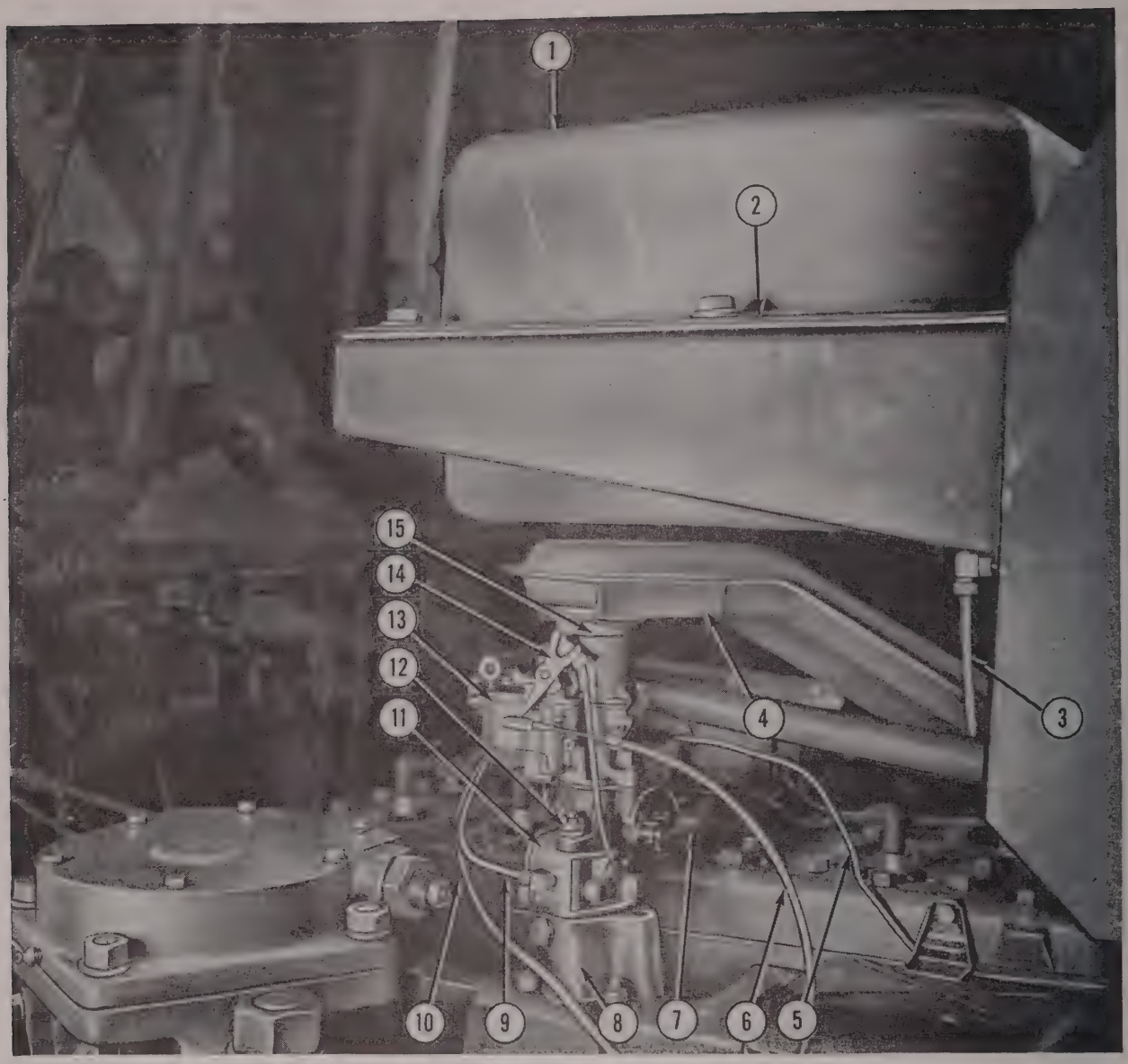
The fuel pump, located on the left side of the engine, is of the diaphragm type. It is driven by the action of a rocker arm, which rests against and is actuated by an eccentric on the camshaft. The fuel pump delivers fuel to the carburetor in accordance with its needs. A fuel filter screen is incorporated in the pump to remove dirt and other foreign matter from the fuel as it is drawn into the pump.

a. Removal.

(1) Disconnect inlet and outlet fuel lines at fuel pump.
(2) Remove two cap screws that secure pump to block.
(3) Remove pump and gasket.

b. Installation.

(1) Position new gasket and pump against engine block.
(2) Install two holddown cap screws and tighten securely.
(3) Connect inlet and outlet fuel lines to pump; tighten flare nuts down until snug against fittings.



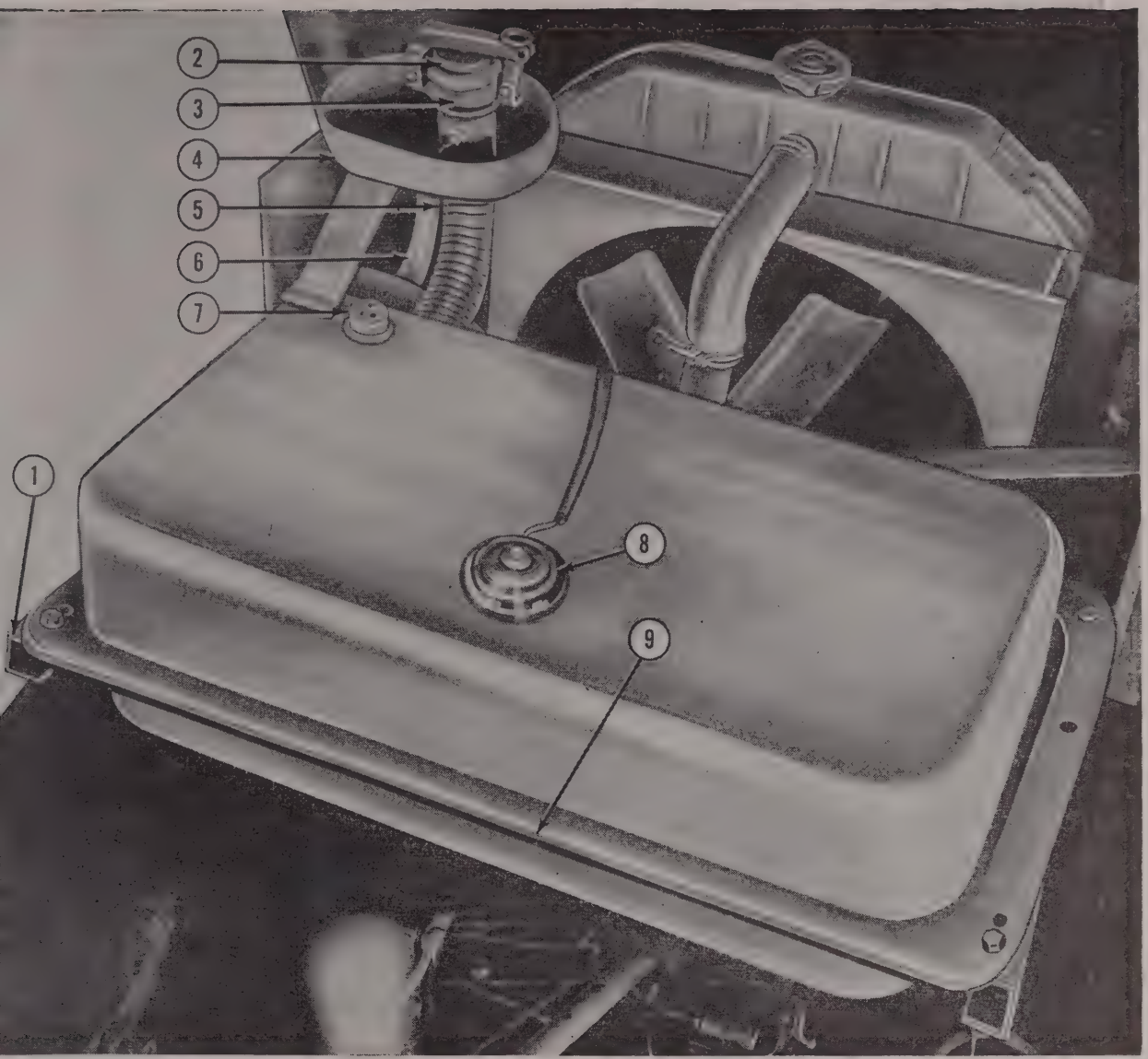
1	Fuel tank	6	Choke linkage	11	Governor
2	Fuel tank support mounting angle	7	Throttle control arm	12	Carburetor throttle body
3	Fuel line to pump	8	Manifold intake	13	Carburetor main body
4	Air cleaner tube	9	Governor differential vacuum line	14	Choke control arm
5	Carburetor-to-distributor vacuum line	10	Fuel line from pump	15	Carburetor air horn

Figure 20. Fuel system.

(4) Prime pump by starting engine; inspect for leaks and proper operation.

51. Fuel Tank

The 20-gallon, flat-type, fuel tank (fig. 21) is located beneath the operator's seat and is mounted on two channels which project from and are welded to the seat frame uprights. The tank is seam-welded and the seams form the flanges for attachment to the channels. The tank filler neck is of flexible metal-covered hose which extends upward to the filler cap assembly. An overflow pan and pipe are located beneath the filler cap assembly to accommodate overflow or spillage when refueling. Breather and fuel gage tank unit are mounted on top of the tank.



1 Tank mounting support
2 Safety filler cap assembly
3 Filler neck
4 Overflow pan
5 Filler hose
6 Overflow drain line
7 Vent
8 Fuel gage tank unit
9 Tank mounting flange and seam

Figure 21. Fuel tank.

a. Removal.

(1) Tilt seat back.
(2) Drain tank.
(3) Close valve at left side of the bottom of the tank.
(4) Disconnect tank-to-fuel pump line.
(5) Disconnect tank fuel gage unit wire at tank unit.
(6) Remove bolt, nut, and washer from each corner of tank and lift tank up and out.

b. Installation.

(1) Position fuel tank on channel supports and install bolts, nuts, and washers at four corners of tank seam flange.
(2) Connect fuel gage wire to tank unit.
(3) Install tank-to-fuel pump line. Tighten for snug fitting.
(4) Open valve at left side of tank bottom.
(5) Refill fuel tank and observe to see that fuel gage is operating properly.
(6) Lower seat into place.

Section III. EXHAUST SYSTEM

52. Muffler

The muffler is located on the right side of the engine and mounted on the crane frame. It reduces the pressure of the exhaust gases from the engine cylinders, thereby muffling the noise of the engine exhaust action.

53. Exhaust Pipes

An exhaust pipe (muffler inlet pipe) is connected to the engine manifold on the left side of the engine and passes beneath the engine to the right side, where it is joined to the muffler. A second exhaust pipe (tail pipe) carries exhaust gases from the muffler out under the right side of the crane. If muffler or exhaust pipes are defective, replace them as follows:

a. Removal.

(1) Remove two nuts, washers, and bolts that secure exhaust manifold flange to muffler inlet pipe.

(2) Remove two cap screws that secure muffler to crane frame.

(3) Remove two cap screws and clamp from tail pipe where it leaves frame.

(4) Remove muffler inlet pipe, muffler, and tail pipe as a unit.

(5) Remove two nuts, washers, U bolt, and clamp that secure tail pipe to muffler outlet. Remove tail pipe.

(6) Remove muffler inlet pipe from muffler.

b. Installation.

(1) Install inlet pipe to muffler and tighten clamp securely.

(2) Position tail pipe to muffler outlet; install clamp, U bolt, and washers and nuts. Tighten securely.

(3) Position tail pipe and clamp to crane frame. Tighten cap screws securely.

(4) Install muffler on crane frame and tighten two holddown cap screws securely.

(5) Install muffler inlet pipe to exhaust manifold flange, using new gasket. Secure with two bolts, washers, and nuts. Tighten nuts securely.

Section IV. COOLING SYSTEM

54. Radiator

The radiator consists of a fin and tube-type core with a water tank at the top and a sediment tank at the bottom. It is located in the rear of the crane; the upper and lower tanks, side channel members, and the radiator core constitute an all-welded construction forming a single-unit assembly. A pusher-type fan draws hot air from above the engine and forces this air through the radiator core. Two support rods at opposite sides provide a rigid bearing for the radiator. It is protected by fabricated louver bars, which are set in the rear of the seat frame.

a. Removal.

(1) Drain cooling system.

(2) Remove upper and lower hose clamps.

(3) Remove machine screws that secure radiator grille; remove grille.

(4) Remove vertical mounting nuts and bolts that secure radiator to support bracket; remove radiator.

b. Installation.

(1) Position radiator and install vertical mounting bolts. Tighten nuts securely.

(2) Position grille and secure with machine screws.

(3) Install radiator hoses and tighten clamps until hose installation is secure.

(4) Refill cooling system.

55. Water Pump

The centrifugally operated vane-type water pump is located in the front end of the engine. It consists of a shaft locked in a pulley, an impeller blade assembly, and the pump housing. The impeller blade assembly is driven by a belt from the fan shaft pulley and circulates water from the radiator through the cylinder head cores and cylinder block water jackets to cool the engine.

a. Removal.

(1) Drain cooling system.

(2) Loosen mounting screws on fan frame and lower frame until water pump drive belt may be removed from pump pulley.

(3) Remove four water pump cap screws and washers, and lift pump assembly from engine block.

b. Installation.

(1) Position pump to front of engine and install four washers and cap screws. Tighten cap screws securely.

(2) Install drive belt on water pump pulley and raise fan mounting frame until drive belt is tight and firmly seated on both generator and pump pulleys. Tighten fan frame mounting screws until frame is secure.

(3) Adjust fan drive belt and water pump and generator drive belt to a 1-inch finger-pressure deflection.

(4) Refill cooling system.

56. Thermostat

The thermostat is mounted on the inside of the water outlet elbow casting on the cylinder head. It controls the flow of coolant to the engine. The thermostat opens at 165° F. and is fully open at 185° F.

a. Removal.

(1) Drain cooling system.

(2) Loosen hose clamp and remove hose from outlet elbow casting.

(3) Remove three nuts from outlet elbow casting mounting studs.

(4) Lift outlet elbow casting off studs, and remove thermostat and outlet elbow casting gasket.

b. Installation.

(1) Place new gasket over outlet elbow casting mounting studs.

(2) Install thermostat in cylinder head with bellows portion down.

(3) Install outlet elbow casting on studs and secure with three nuts.

(4) Install hose to casting and tighten hose clamp until fitting is snug.

(5) Refill cooling system.

57. Fan and Fan Belt

The four-blade, 18-inch fan is mounted at the center of a steel bar frame which extends across the crane at a point above the engine and just behind the radiator. The fan mounting frame is attached to the seat frame uprights by four cap screws. These cap screws are set in vertical slots and may be moved up or down to raise or lower the fan mounting frame and facilitate the removal or adjustment of the fan belts. Two belts are seated on the fan pulley, one of which extends up from the crankshaft pulley to drive the fan. The second belt is seated on and around both the generator and the water pump pulleys and drives these units from the fan pulley.

a. Removal.

(1) Loosen frame mounting cap screws and lower frame.

(2) Remove fan drive belts from fan pulley.

(3) Remove four mounting cap screws and washers and lift fan mounting frame from crane.

b. Installation.

(1) Position fan mounting frame and install mounting cap screws and washers. Tighten cap screws until finger-tight.

(2) Lower fan frame until belts may be placed on fan pulley.

(3) Install belts on fan pulley; move frame up until belts are in tension; check to see that belts are seated properly on crankshaft, generator, and water pump pulleys.

(4) Tighten mounting cap screws until fan frame is securely installed.

(5) Adjust crankshaft-to-fan drive belt for proper deflection by moving fan mounting frame. If water pump and generator drive belt are not in correct adjustment, loosen two cap screws on generator mounting bracket and move generator out or in to obtain a ½-inch finger-pressure deflection in drive belt.

Section V. ELECTRICAL SYSTEM

58. Wiring System

The wiring system (figs. 22 and 23) consists of six basic circuits: starting, charging, ignition, horn, lighting, and instrument. Figure 22 illustrates manner in which engine units are wired. Figure 23 gives dimensions for forming pertinent instrument panel wiring and identifies leads by color of insulation. It should be referred to when repair involves removal or disassembly of the instrument panel or when wiring is being connected to the plastic junctions between the engine and the instrument panel.

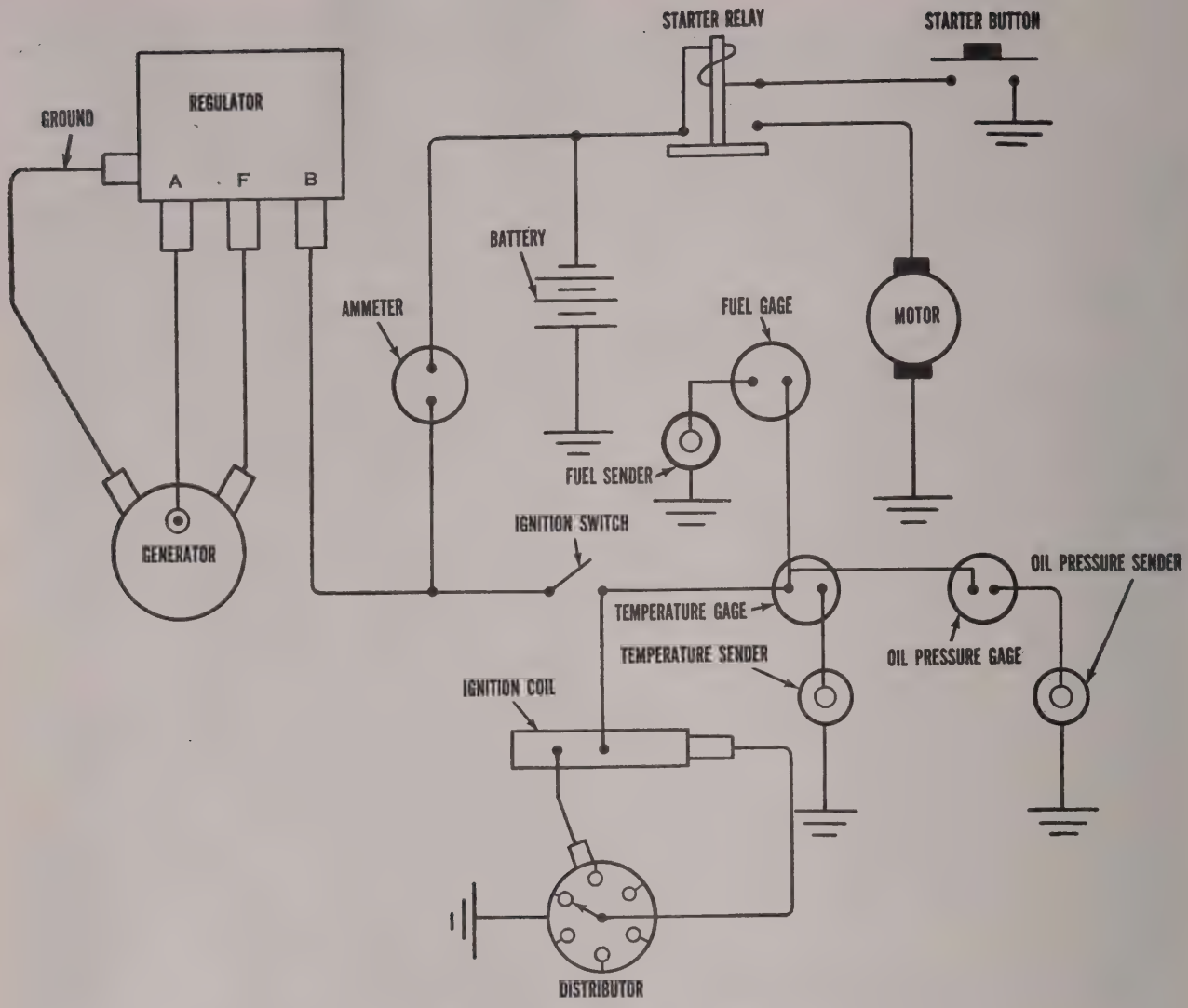


Figure 22. Engine wiring diagram.

59. Starting Motor

The starting motor (fig. 24) is a 6-volt, series-wound, four-brush type, located on the left front side of the engine. The starting motor armature shaft is placed in motion by the action of a solenoid, which is energized when the starting button is depressed. A pinion on the flywheel end of the armature shaft engages the flywheel to start the engine and slips out of engagement when the speed of the flywheel becomes greater than the speed of the armature shaft.

a. Removal.

(1) Disconnect battery cable at starting motor terminal.

(2) Remove bolt that secures starting motor to mounting bracket.

(3) Loosen two through bolts and remove entire starting motor. Tilt motor slightly to move starting motor drive around edge of flywheel.

b. Installation.

(1) Install motor with terminal screw in a vertical position and on top of the motor; tighten outer through bolt enough to hold the starting motor in position.

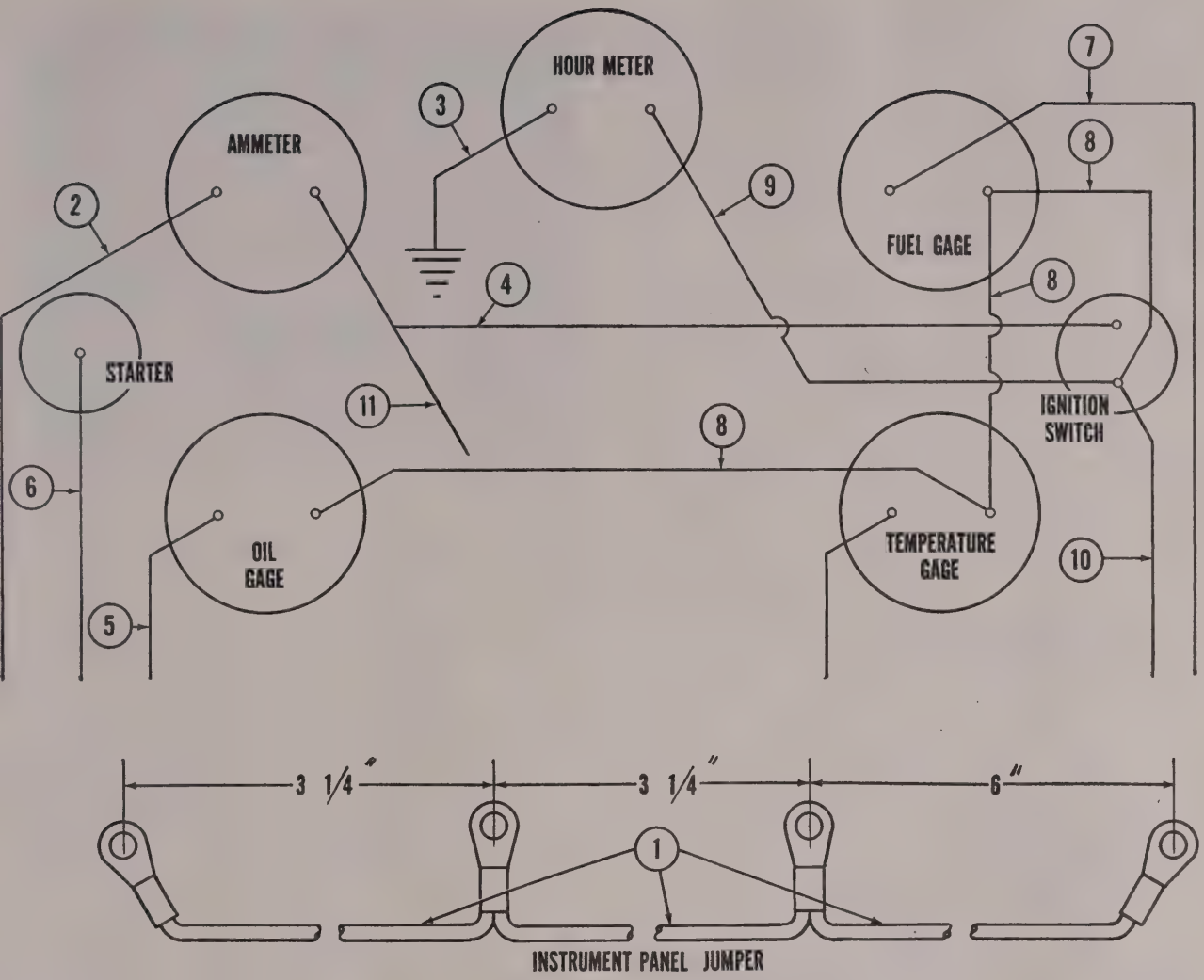
(2) Install bolt in mounting bracket; install washer and nut and tighten finger-tight.

(3) Tighten both through bolts until motor is rigidly mounted; tighten nut on mounting bracket bolt securely.

c. Adjustments and Tests.

(1) *Load test.*

(*a*) Connect the test equipment as shown in



1 Jumper wires (white)
2 Ammeter to regulator battery terminal (green and black)
3 Hour meter ground
4 Ammeter to ignition switch (tan)
5 Oil pressure gage to sending unit (blue)
6 Starter switch to starter solenoid (orange)
7 Fuel gage to sending unit (yellow)
8 Jumper wires (white)
9 Hour meter to ignition switch (black)
10 Ignition switch to coil (red)
11 Ammeter to starter solenoid (red and black)

Figure 23. Instrument panel wiring diagram and wiring system key.

figure 25. Be sure that no current is flowing through the ammeter and carbon pile rheostat portion of the circuit (rheostat at maximum resistance). Crank the engine with the ignition off and determine the exact reading on the voltmeter.

(*b*) Stop cranking the engine and reduce the resistance of the carbon pile until the voltmeter indicates the same reading as that obtained while the starter cranked the engine. The ammeter will indicate the starter current draw under load. This reading should be a maximum of 190 amperes with the engine at normal operating temperature.

(2) *No-load test.*

(*a*) To test the starter at no load while it is mounted on the engine, the engine must be running at idle speed to prevent the starter drive from engaging the flywheel.

(*b*) With the engine idling, make the ammeter connections as shown in figure 26. The no-load current draw on the ammeter should be 45 to 60 amperes.

(3) *Interpretation of load and no-load tests.*

(*a*) Rated torque, current draw, and no-load speed indicate normal condition of starting motor.

(*b*) Low speed and high current draw with low developed torque may result from obstructed armature rotation, grounded armature or field, or shorted armature.

(*c*) Failure to operate with high current draw may be caused by direct grounds at switch, terminals, brushes, or by a frozen armature shaft bushing.

(*d*) Failure to operate with no current draw can be caused by an open field circuit, open armature coils, or poor contact between brushes and commutator.

(*e*) Low no-load speed with low torque and low current draw can be caused by an open field, poor contact between brushes and commutator, or defective leads and connections.

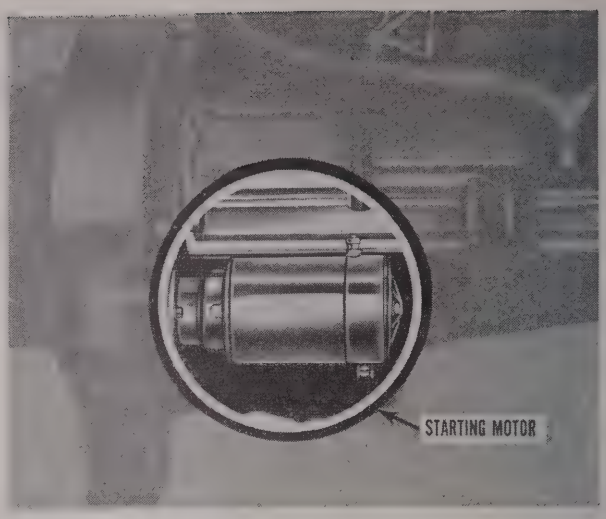


Figure 24. Starting motor.

(*f*) High free speed, low developed torque, and high current draw indicate shorted fields. It is difficult to detect shorted fields with ordinary testing instruments because field resistance is already low. If shorted fields are suspected, install new fields and check for improvement in performance.

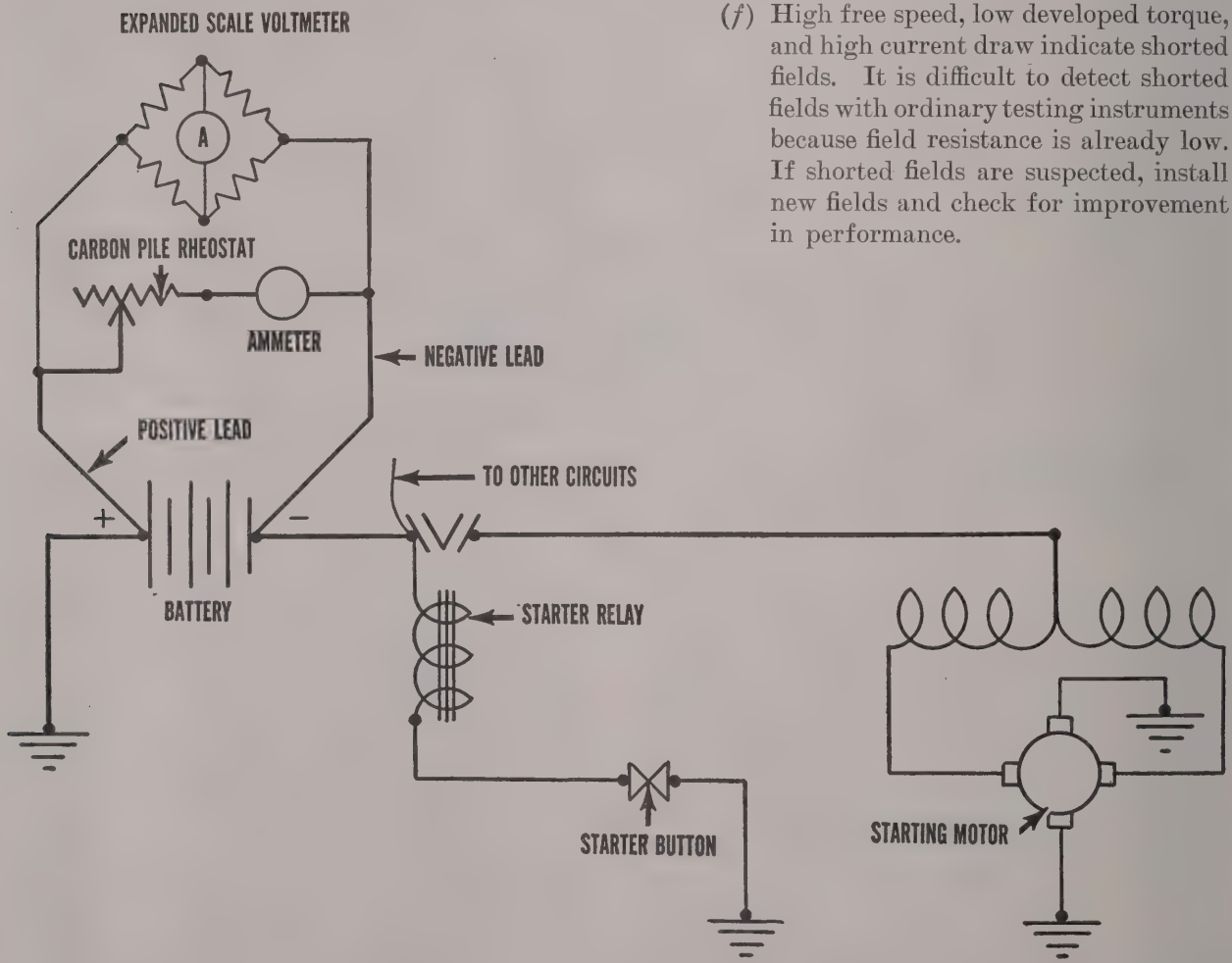


Figure 25. Starter load test—schematic view.

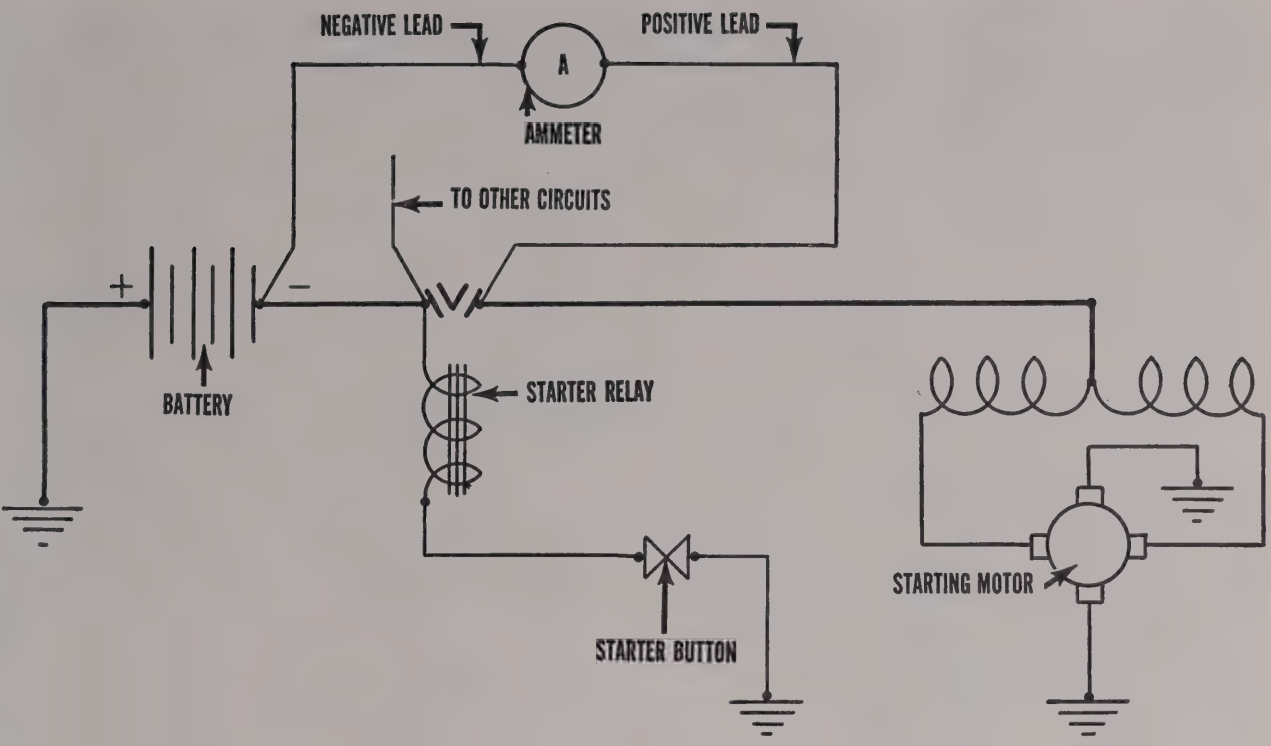


Figure 26. Starter no-load test—schematic view.

60. Generator

The generator (fig. 27) is a two-brush, shunt-wound, high-output type, and is located on the right rear side of the engine. It is driven from the fan pulley by the same drive belt that drives the water pump, and rotates clockwise as viewed from the drive end. The function of the generator is to provide a source of electrical energy to maintain a full charge in the battery.

a. Removal.

(1) On radio-suppressed models, remove suppression shielding from generator.

(2) Disconnect armature, field, and ground wires from generator terminals.

(3) Loosen support screws and adjusting bracket bolts.

(4) Move generator toward the engine to loosen drive belt. Remove drive belt.

(5) Remove adjusting bracket bolts, nuts, and washers; remove support screws; remove generator.

b. Installation.

(1) Position generator and install support screws and adjusting bracket bolts, washers, and nuts. Tighten finger-tight.

(2) Install drive belt on generator pulley and move generator in or out to obtain finger-pressure deflection of 1 inch.

(3) Tighten adjusting bracket bolts securely; then tighten generator support screws until generator is rigidly mounted.

(4) Connect armature, field, and ground wires to generator terminals.

(5) If unit is radio suppressed, install generator shielding.

(6) Start engine and inspect charging rate of ammeter.

c. Generator Output Test.

(1) *On the engine.* Disconnect the regulator armature and field wires. Connect a jumper wire from the generator armature terminal to the generator field terminal and the negative lead from a 0–50 ammeter to the generator armature terminal. Start the engine and immediately connect the ammeter positive lead to the battery. Run the engine at 1,500 revolutions per minute and read the current output on the ammeter. The generator output should reach or exceed 35 amperes. Stop the engine and disconnect

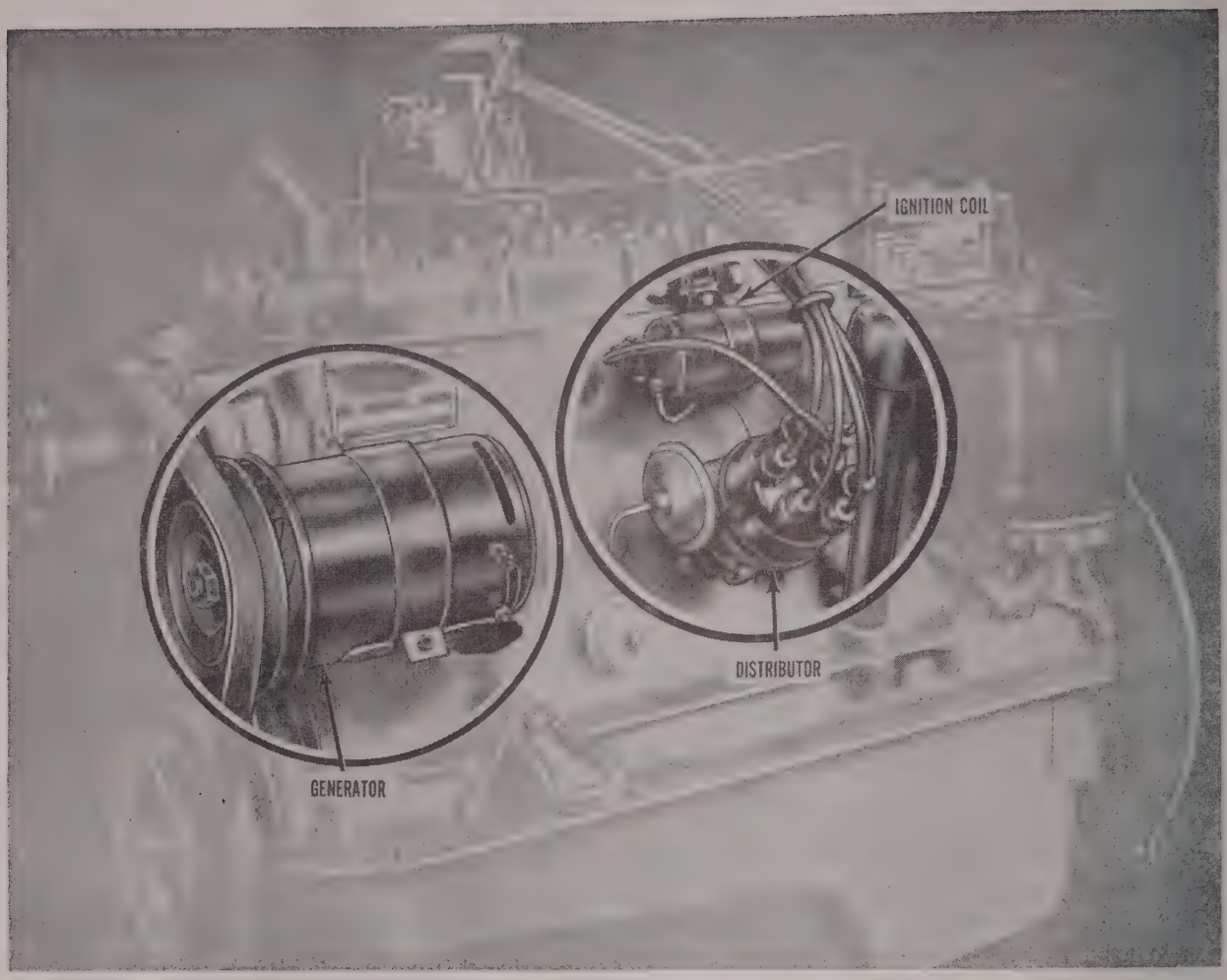


Figure 27. Generator, ignition coil, and distributor.

test leads, when the test is completed, to prevent overheating the generator.

(2) *On test bench.* When the generator output test is conducted on the test bench, a resistance built into the machine is inserted into the field circuit to change output while the generator revolutions per minute remain constant.

d. Armature and Field Open Circuit Test. An open circuit in the armature may often be detected by a close examination of the commutator for evidence of burning. A burned commutator is caused by an arc formed every time the commutator segment connected to the open circuit passes under a brush. An open circuit in the armature may be checked by means of a test light, holding one lead on one commutator segment while touching each of the remaining segments with the other lead. If the test light fails to light, an open circuit exists. An open circuit test of the field can be made on the engine as described in (1) below or on the test bench as described in (2) below.

(1) *On the engine.* Disconnect the field lead from the generator terminal. Connect a 0–5 ammeter from the battery to the field terminal. The normal current draw registered on the ammeter should be 1½ to 2½ amperes. If there is little or no current flow, the field has a high resistance or is open.

(2) *On test bench.* The field circuit may be tested on the bench in the same manner as described in (1) above except that a return lead must be used to connect the generator frame to the battery.

e. Armature and Field Grounded Circuit Test. This test may be performed on the bench only. To test the field windings for a grounded circuit, remove the ground terminal stud from the gen-

erator frame. Connect a jumper lead to the battery positive terminal and the generator frame; connect the voltmeter negative lead to the negative terminal on the battery. Connect the voltmeter positive lead to the field terminal on the generator frame. If the voltmeter registers any voltage, the field coils are grounded. To determine if the armature windings are grounded, connect the voltmeter negative lead to the battery and connect a jumper lead from the positive side of the battery to the armature core. Place the voltmeter positive lead against the winding; if the voltmeter registers any voltage, the armature windings are grounded to the frame. Do not touch test leads to bearing surface.

f. Armature Short Circuit Test. Use a growler to test the armature for a short circuit in the windings. Place the armature on the growler and rotate slowly by hand. Hold a steel strip above the core, in line with the core slots. When the shorted winding is immediately beneath the steel strip, it will cause the strip to vibrate.

61. Regulator

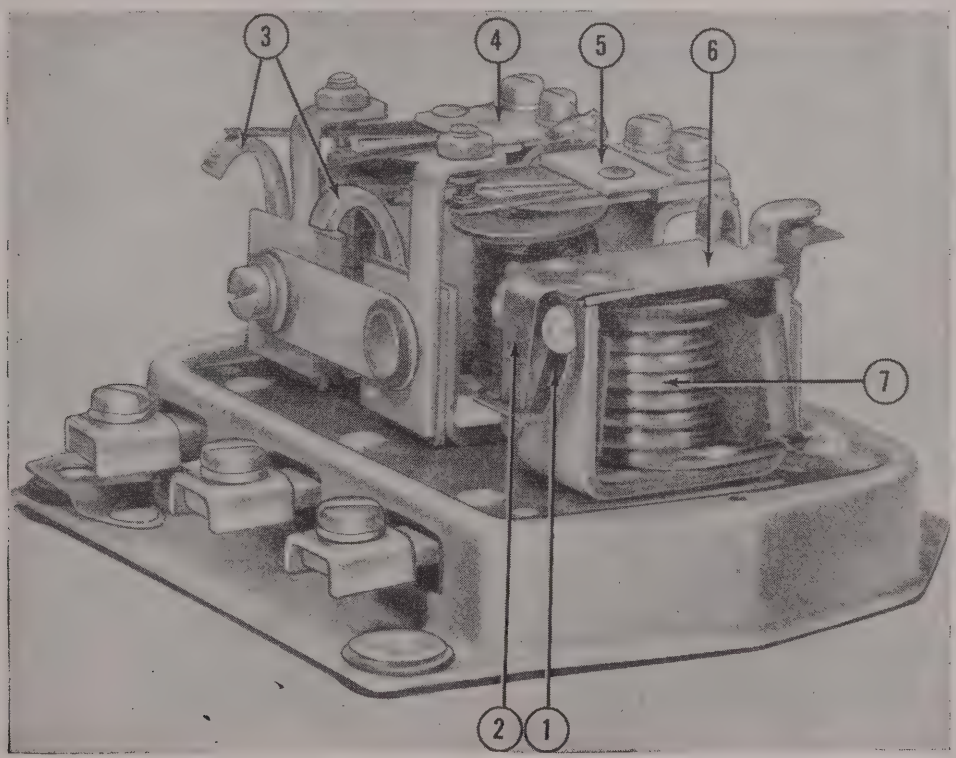
The regulator (fig. 28) is mounted on the right side of the engine. It consists of the voltage regulator, which prohibits the generator from delivering more voltage than required by the battery; the current regulator, which controls generator amperage output in conformance with the needs of the battery; and the cutout relay (circuit breaker), which automatically closes the circuit between the generator and the battery when voltage developed exceeds that of the rated capacity of the battery.

a. Removal.

(1) Disconnect either battery cable to prevent possible short circuit of battery-to-ground lead.

(2) Disconnect all leads to regulator terminals; mark leads to assure correct installation.

(3) Remove mounting screws and remove regulator.



1 Cutout adjusting arm
2 Armature spring
3 Current limiter adjusting arm
4 Voltage limiter
5 Current limiter
6 Cutout relay
7 Cutout relay coil

Figure 28. Regulator.

b. Installation.

(1) Position regulator and secure with mounting screws.

(2) Refer to markings on regulator leads and install leads on proper terminals. Tighten connections.

(3) Connect battery cable and tighten until secure.

c. Cutout Relay Test.

(1) Connect regulator to proper generator and a fully charged battery of proper capacity.

(2) Connect ammeter in series with regulator battery terminal and lead removed from terminal.

(3) Connect voltmeter from regulator armature terminal to regulator base.

(4) Place thermometer about 2 inches from regulator cover. Do not touch regulator.

(5) Disconnect field lead from regulator field terminal and insert a variable resistance (3-ampere to 50-ohm capacity) between lead and regulator terminal.

(6) Run generator at about 1,000 revolutions per minute.

(7) Place all resistance in field circuit; then slowly reduce resistance and note voltage reading just before change caused by closing of cutout relay.

(8) Increase charging rate to specified figure; then reduce charging rate by inserting resistance in field circuit. Note voltmeter and ammeter reading just before cutout relay opens and ammeter reading drops to zero. Closing voltage and opening voltage should be within the limits specified in table IV.

d. Cutout Relay Adjustment. To adjust closing voltage, bend the adjusting arm at inside edge of armature spring. Bend the arm upward to increase closing voltage and bend the arm downward to decrease closing voltage.

e. Voltage Regulator Adjustment. If the voltage limit is less than specified in table IV, increase the armature spring tension by bending the adjusting arm upward. To decrease the voltage limit, bend the adjusting arm downward.

f. Current Regulator Adjustment. If the current limit is less than specified in table IV, increase the spring tension by bending the adjusting arm upward. To decrease the current limit, bend adjusting arm downward.

g. Specifications. The regulator specifications in table IV below should be used in connection with regulator tests.

Table IV. Regulator Specifications

Cutin Voltage		Voltage Regulation		Amperage Regulation	
Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
6. 0	6. 6	7. 2	7. 6	30	34

62. Ignition Coil

The ignition coil (fig. 29) transforms low voltage, supplied by the battery, into high voltage necessary for the arc between the spark plug electrodes to bridge the spark plug gap. The ignition coil is constructed of two windings on a soft iron core which, together with a soft iron shell inclosing the windings, complete the magnetic circuit. This unit is bracketed to the cylinder head at the right side of the engine.

a. Removal.

(1) Disconnect the high tension and primary leads at the coil.

(2) Loosen coil mounting strap and remove coil.

b. Installation.

(1) Position the coil in the mounting strap and tighten strap securely.

(2) Insert high tension lead into the coil socket and connect primary lead to coil. Tighten securely.

63. Distributor

The distributor distributes high tension voltage to the spark plugs. The distributor cap is held in place by two spring clamps and is designed to accommodate six spark plug leads and the high tension lead from the ignition coil. A gear on the end of the distributor shaft meshes with a splined recess in the oil pump drive gear, which is driven by a gear on the camshaft, the oil pump and distributor drive shafts rotating as a unit. The distributor shaft rotates clockwise, causing a projecting point on the rotor to contact each of six stationary points along the circumference of the distributor cap interior. The hexagonal breaker cam also turns clockwise on the distributor shaft and closes the breaker points to transmit electrical impulses to each of the stationary points and, when properly timed with the rotor, assures correct fir-

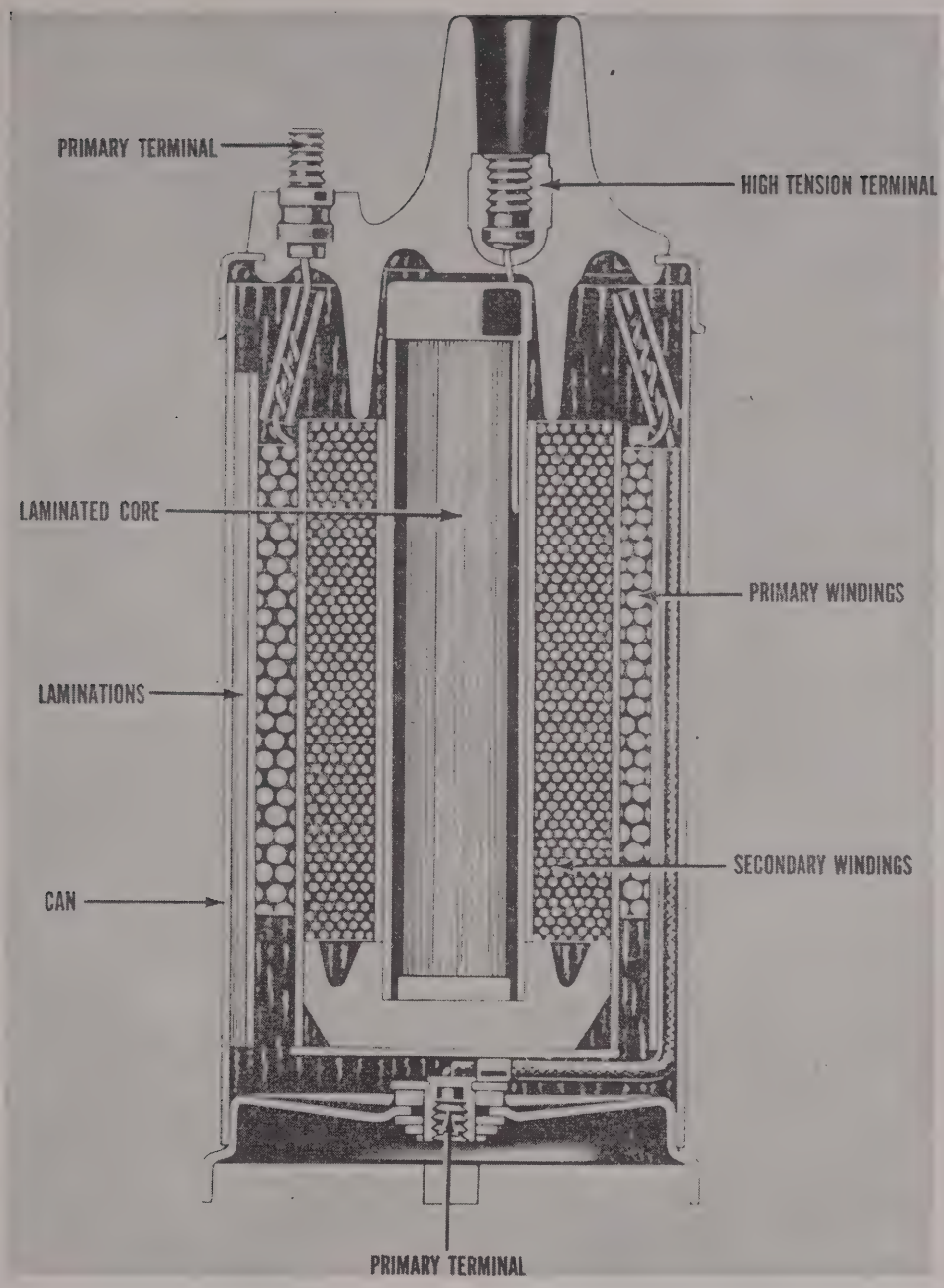


Figure 29. Ignition coil—sectional view.

ing of spark plugs. The distributor is equipped with a vacuum diaphragm, which is attached to the carburetor at one end and enters the distributor breaker plate at the other. Two breaker plate springs work against diaphragm vacuum to control spark advance in direct relation to the speed of the engine.

a. Removal.

(1) Mark distributor housing to indicate position of the rotor; mark engine and housing to indicate position of housing for reinstallation.

(2) Remove distributor cap.

(3) Disconnect coil and spark plug leads.

(4) Remove vacuum line from diaphragm.

(5) Loosen distributor clamp lock screw and remove distributor from engine.

b. Installation.

(1) Aline rotor with mark on distributor housing.

(2) Note engine and housing marks made during removal and install distributor in engine.
(3) Install distributor cap and connect coil and spark plug leads.
(4) Tighten holding clamp screw securely; install vacuum line on diaphragm; tighten nut securely.
(5) Check and adjust ignition timing.

64. Spark Plugs

a. Removal.
(1) Remove leads at spark plugs.
(2) Clean area around each spark plug.
(3) Remove spark plugs with a socket wrench to prevent breaking porcelain casing. Be sure to remove spark plug gaskets when spark plugs are removed.
(4) Set spark plug gaps at .025 inch, using feeler gage.

b. Installation.
(1) Clean area around spark plug ports for proper seating of gaskets. Install new gaskets, lightly coated with engine oil.
(2) Insert spark plugs in spark plug ports and turn down until finger-tight.
(3) Using a socket wrench, draw plugs down tightly against gaskets, making sure that gaskets are evenly seated.
(4) Connect spark plugs leads to spark plugs and operate engine until it reaches normal operating temperature; disconnect spark plug leads.
(5) Tighten each spark plug to 24 to 30 pound-feet torque and reinstall spark plug leads.

65. Radio Suppression

a. General. V–10 cranes designated by model number V–10 (RS) are equipped with radio-interference suppression devices designed to eliminate interference with radio transmission and reception. On these models radio suppression has been accomplished by insulating electrical units of the engine with shielding shown in the radio-suppression kit illustrated in figures 30 and 31. The kit may be installed by the organization mechanic on cranes not equipped with radio suppression on receipt by the using organization. All wiring is fungusproof and moistureproof. If the installation is to be performed by the organization mechanic, special mounting brackets for the filters, voltage regulator, and coil must be provided.

b. Application.
(1) Fashion a bracket for the two filters and voltage regulator, using steel plate of ⅛-inch thickness or greater. Steel plate should be trimmed to 12 by 9 inches and formed into a channel 10 by 9 inches. Necessary holes to accommodate the mounting brackets for the two filters and voltage regulator shielding must be drilled before the bracket is installed. Position the bracket on the right crane side frame at a point 1 inch to the rear of the winch mounting bracket and 2½ inches below the side frame top. Weld channel cleats to side frame with the 10-inch face of bracket running parallel to the top of the side frame.
(2) Using similar piece of steel plate, large enough to use as a mount for the coil shielding, drill holes necessary for the installation of the coil shielding mounting clamp. Weld bracket to engine mount on right side of engine.
(3) Disconnect battery cable to prevent short occurring during installation of shielding.
(4) Remove distributor cap, coil, and spark plugs and leads.
(5) Turn engine to bring timing mark on engine end of main power take-off pulley in line with timing bracket on rear end of engine. This will set distributor rotor arm in up position for No. 1 cylinder or down position for No. 6 cylinder. Note position of rotor arm and distributor in relation to engine.
(6) Disconnect vacuum line at diaphragm and remove distributor. Place rotor arm to one side.
(7) File down and remove distributor shaft collar pin. Remove shaft through top of distributor breaker plate.
(8) Remove distributor vacuum control diaphragm retainer.
(9) Remove two attaching screws from distributor housing and remove diaphragm.
(10) Remove diaphragm vacuum springs from mounting pins.
(11) Remove breaker plate snap ring and remove breaker plate.

(12) Remove breaker plate ground wire and primary wire from terminals at distributor base. Place ground wire terminal screw to one side for use later when installing shielding.

(13) Remove distributor oil cup and packing and install in corresponding hole in distributor shielding base.

(14) Remove distributor timing arm assembly.

(15) Remove diaphragm spring mounting pins from distributor base and place to one side for installation in shielding.

(16) Place distributor shielding base in vise. Insert two diaphragm spring mounting pins in two adjacent holes with machined surfaces; tighten securely.

(17) Install gasket on vacuum inlet and install end of diaphragm tube in distributor base. Position diaphragm and install two countersunk screws from kit to make secure.

(18) Install ground wire, using screw saved for this purpose, in remaining small hole in distributor shielding base.

(19) Install distributor-to-coil cable elbow assembly on adapter; connect loose distributor primary lead to terminal on end of elbow assembly.

(20) Push down on coil terminal, making sure it is depressed enough not to contact breaker plate when installed.

(21) Position breaker plate; depress breaker plate and install snap ring.

(22) Install diaphragm springs; install diaphragm control rod and secure with retainer.

(23) Position distributor shaft and tap in through top of breaker plate.

(24) Install collar and new rivet from kit; check to see that shaft moves freely.

(25) Install lock washers and distributor cap retaining clips on screws; install screws in distributor cap mounts and tighten finger-tight.

(26) Remove distributor from vise. Position and install in engine, making sure that distributor is all the way down in the mounting well and occupies same relative position as when removed. Install distributor timing arm assembly, reversing normal position.

(27) Replace rotor, with arm at No. 1 cylinder position or at No. 6 cylinder position, according to setting when removed.

(28) Install vacuum line to diaphragm; tighten distributor mounting bracket securely.

(29) Install special spark plugs and tighten to proper torque.

(30) Install spark plug cables, elbow ends to spark plugs and adapter nut ends to distributor adapters. Proceed from left to right, No. 1 to No. 6, and tighten adapter nuts. Insert spark plug leads in corresponding holes in distributor cap.

(31) Push distributor cap down into shielding until retaining clips on mounts may be forced into cap insets. Retaining clip screws may now be tightened securely. Do not install distributor shielding cover at this time.

(32) Remove coil mounting bracket and clamp; disconnect leads to coil terminal.

(33) File and round off projection on circumference of top surface of coil between terminals. Remove terminal nuts and place to one side.

(34) Remove four screws and washers and remove coil retaining ring from coil shielding body.

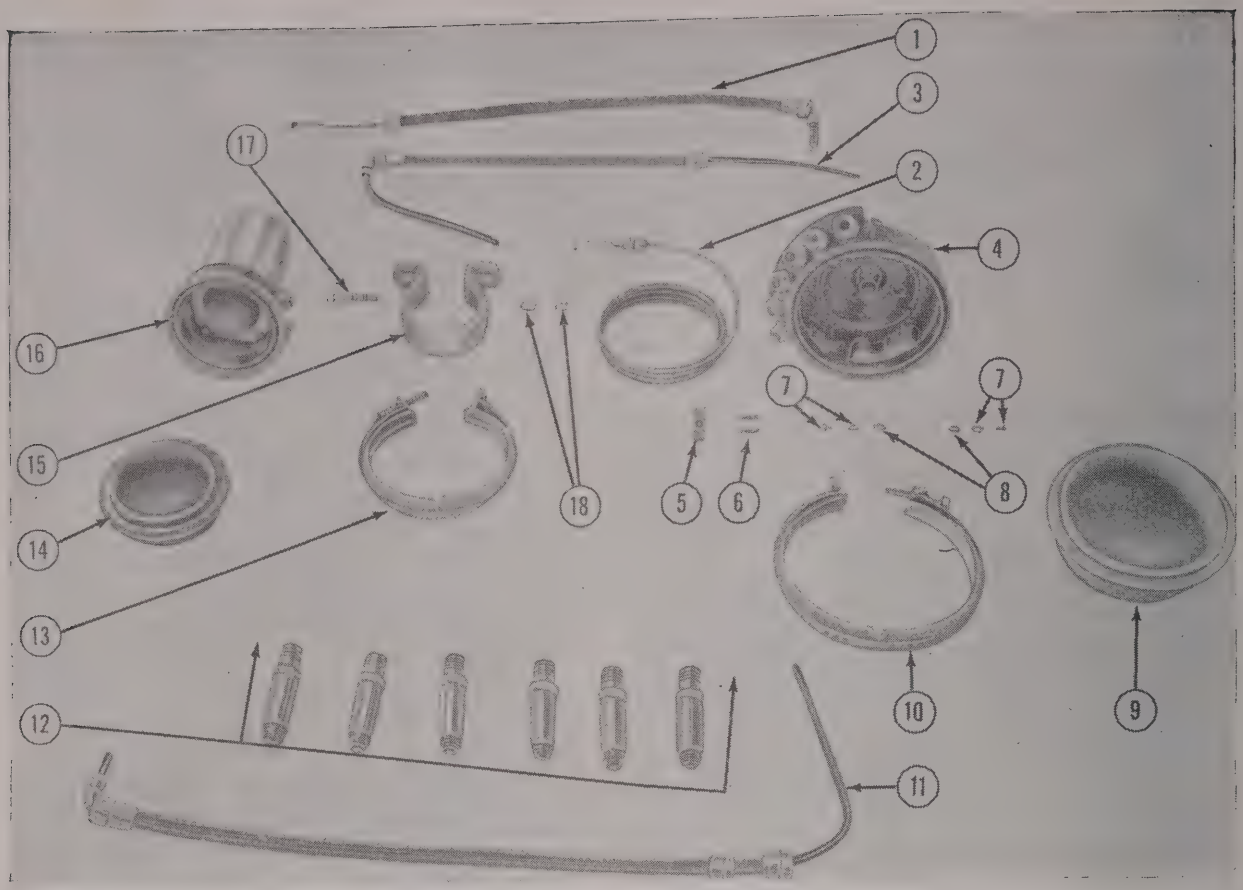
(35) Position coil in shielding body with terminals opposite adapter outlets.

(36) Replace retaining ring and tighten with four screws and washers.

(37) Install coil-to-filter elbow on coil adapter and connect lead to coil battery terminal. Install and tighten terminal nut.

(38) Install loose end of low tension coil-to-distributor cable on second of two adjacent adapters and tighten adapter nut securely. Pull lead from this cable through adapter and install on coil distributor terminal.

(39) Install high tension distributor-to-coil cable elbow to remaining adapter on coil shielding body. Pull lead through adapter and install in top of coil. Install other end of cable on remaining adapter in distributor shielding base and install lead in center hole of distributor cap.



1 Distributor-to-coil low tension lead
2 Pitot tube and vacuum line
3 Distributor-to-coil high tension lead
4 Distributor shielding base
5 Vacuum inlet gasket
6 Diaphragm mounting screws
7 Distributor hold-down clamp screws and washers
8 Distributor hold-down clamps
9 Distributor shield cover
10 Distributor retaining band
11 Spark plug-to-distributor lead (6)
12 Spark plugs
13 Coil retaining band
14 Coil shield cover
15 Coil shield mounting clamp
16 Coil shield body
17 Coil shield mounting clamp adjusting screw
18 Coil shield mounting clamp adjusting screw nut and washer

Figure 30. Radio-suppression kit for coil and distributor.

(40) Position coil on engine mounting plate and install two bolts through shield mounting clamp and mounting plate. Install nuts and tighten securely.

(41) Install covers on distributor and coil shielding bodies. Be sure O rings are evenly seated and will hermetically seal the shielding bodies when retaining bands are installed. Install retaining bands and tighten securely.

(42) Remove screws and remove voltage regulator mounting bracket.

(43) Remove three screws, nuts, and rubber washers and remove voltage regulator from bracket.

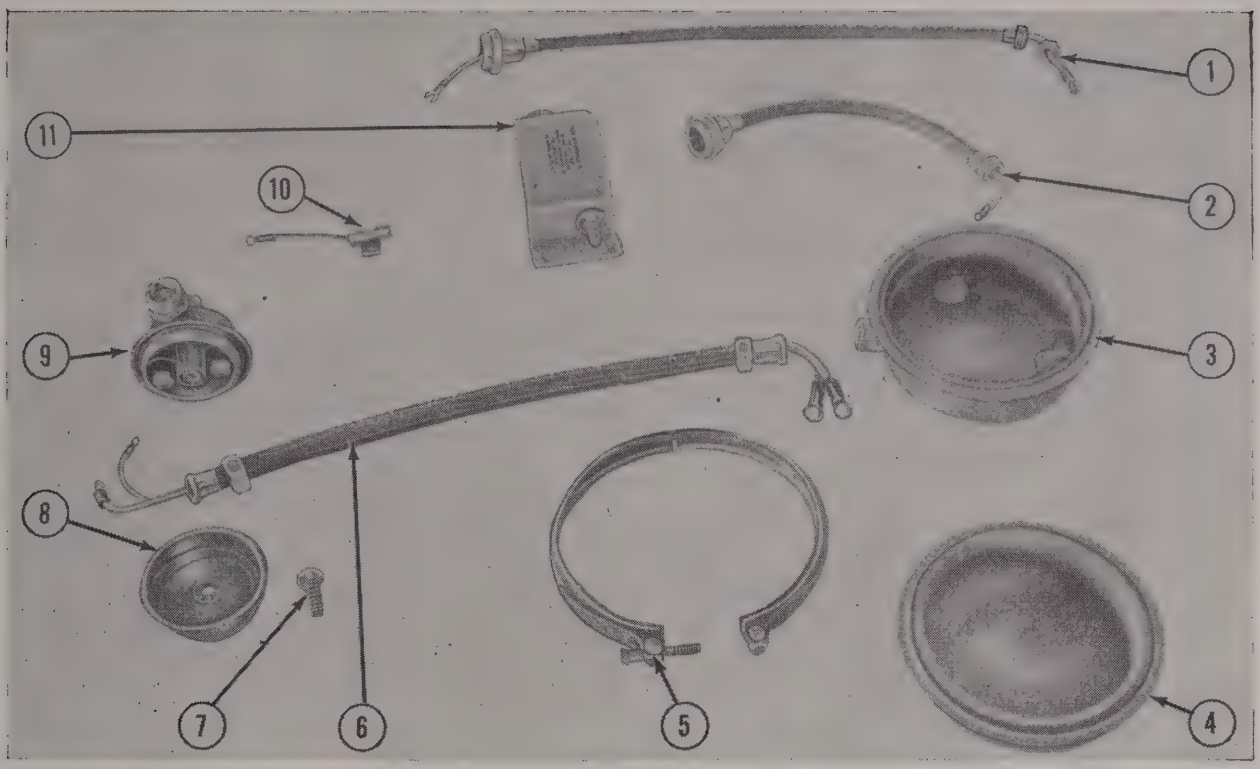
(44) Disconnect all leads at generator and regulator. Put regulator terminal screws and clamps aside for use with shielding. Discard three generator leads.

(45) Remove ground wire from mounting screw.

(46) Install regulator in shielding base. Install three fillister head screws and washers from kit and tighten securely.

(47) Install regulator-to-generator cable to large regulator adapter. Pull leads through adapter and connect to regulator armature and field terminals.

(48) Install filter-to-regulator cable on small regulator shielding body adapter. Pull lead through adapter and connect to reg-



1 Filter-to-coil cable
2 Filter-to-regulator cable
3 Regulator shield base
4 Regulator shield cover
5 Regulator shield retaining band
6 Generator-to-regulator cable
7 Generator junction box cover retaining screw
8 Generator junction box cover
9 Generator junction box body
10 Temperature gage suppressor
11 Shielded filter assembly

Figure 31. Radio-suppression kit for regulator and generator.

ulator battery terminal. Install remaining end of cable on filter adapter and tighten adapter nuts at both connections.

(49) Remove generator.

(50) Remove nuts and washers from through bolts and remove generator rear end plate.

(51) Remove generator cover.

(52) Cut field wire from lead mount on end plate.

(53) Remove generator field terminal screw from cover; discard.

(54) Tap hole left by removal of terminal screw for ½-inch pipe fit.

(55) Solder about 6 inches of 14-gage wire to loose end of field wire and tape until well insulated.

(56) Screw ½-inch pipe nipple on generator junction box into tapped hole, making sure that nipple is at right angles to the normal position of the generator shaft and is screwed straight and tight.

(57) Remove armature lead terminal bolt and install on end plate in reversed position with bolt head on outside of end plate.

(58) Solder 5/16-inch eye to each end of a 6-inch length of 16-gage wire. Install one eye on armature lead terminal.

(59) Replace generator cover. Lead loose ends of leads through shielding nipple and install end plate and through bolts.

(60) Install loose end of regulator-to-generator cable to adapter on generator junction box body. Tighten adapter nut securely.

(61) Pull leads from cable through adapter. Connect both field leads to same terminal; connect both armature leads to same terminal. Be sure this step in installation is correct.

(62) Install generator junction box cover and tighten with retaining screw. Do not tighten too far as O ring may be mashed

and cause loss of vacuum in future installations.

(63) Install generator on original engine mounts.

(64) Solder 5/16-inch eye to end of lead from ammeter. Connect to terminal on top of filter.

(65) Cut battery lead to coil about 4 inches out from wiring harness. Splice about 20 inches of similar gage wire to cut end of this lead. Tape until splice is well-covered and solder 5/16-inch eye to loose end. Install eye on top terminal of remaining filter and secure with nut and washer.

(66) Drill hole in air cleaner tube at front side of tube immediately above the cylinder head. Install Pitot tube fitting from kit and solder in place securely. Turn Pitot tube in direction of air flow.

(67) Lead copper tubing from Pitot tube down to distributor and install in vent fitting. Tighten retaining nuts at both ends of tubing.

(68) Tap cylinder head hold-down bolt (second from rear at right side of cylinder head) for 10–32 screw. Attach temperature gage suppressor mounting bracket to this bolt with proper screw. Connect eye on suppressor lead to temperature gage terminal. Tighten securely.

66. Gages and Instruments

The temperature, oil pressure, and fuel gages each consist of two units: an indicating unit on the instrument panel and a sending unit at the point of measurement. The hour meter works only when the ignition switch is turned on.

a. Panel Removal.

(1) Remove three cap screws at top and two cap screws at bottom of panel.

(2) Remove panel retainer bar; lift panel up and to the rear to expose wiring.

(3) Disconnect wiring from instruments and switches and remove panel. Note marking on wires to assure correct reinstallation.

b. Panel Installation.

(1) Connect wiring to instruments and switches; check to see that terminals are clean and connections secure. Be sure that each wire is connected to the proper terminal.

(2) Position panel on mast support frame and install retainer bar; insert two cap screws at ends of retainer bar and tighten securely.

(3) Insert three cap screws at base of instrument panel and tighten securely.

Section VI. POWER TRAIN

67. Clutch

Power from the engine is transferred to the transmission by means of a single-plate, dry-disk clutch. The clutch cover, containing the pressure plate and driven disk, is bolted to the engine flywheel. The clutch drive shaft (transmission main shaft) is splined to a universal joint at the differential end and to the hub of the driven disk at the flywheel end. When the clutch is engaged, the universal joint rotates to transfer power from the transmission to the differential. The clutch bearing carrier, mounted between the transmission case and the clutch cover, is controlled by the operation of the clutch pedal to engage or disengage the clutch drive shaft.

a. Removal.

(1) Tilt seat back.

(2) Raise front of crane and block.

(3) Unscrew shifting lever caps and remove shifting levers.

(4) Disconnect clutch linkage beneath housing.

(5) Remove universal joint companions between transmission and differential and remove drive shaft.

(6) Remove two rear transmission support bolts that secure support to frame.

(7) Raise and securely block front of engine, at least 2 inches above transmission support.

(8) Remove eight cap screws and washers from clutch bell housing.

(9) Slide transmission forward and turn crosswise.

(10) Lower transmission to ground.

(11) Remove six cap screws and washers that secure clutch cover to flywheel; remove clutch assembly.

b. Installation.

(1) Install clutch cover to flywheel. Install cap screws one at a time; tighten finger-tight; then tighten evenly until installation is secure.

(2) Position transmission and install eight cap screws that secure transmission case flange to clutch bell housing. Tighten evenly and securely.

(3) Remove blocking and lower engine and transmission until transmission rests on transmission support.

(4) Install two rear transmission support bolts and nuts. Tighten until transmission support is attached securely to frame.

(5) Connect clutch linkage.

(6) Install shifting levers and shifting lever caps.

(7) Remove blocking and lower front of crane.

(8) Lower operator's seat.

(9) Test clutch for proper operation; adjust linkage where necessary.

68. Transmission

The crane is equipped with a four-speed transmission that provides four speeds forward and four speeds reverse. The transmission assembly (fig. 32) actually consists of two cases: the forward transmission case, which houses the forward and speed gears; and the reverse transmission case. These two cases are joined by a common shaft, and the gears in each are synchronized to provide four-speed travel in either direction. Gear ratios are the same both in forward and reverse. When the direction gear shift lever is placed in the forward position, the sliding selector gear is shifted from a neutral position between the two transmissions into engagement with the reverse idler gear. This action causes the driving gear on the reverse idler shaft to be driven by the countershaft gear, which is in constant mesh with the main drive gear. It also causes the input shaft of the forward transmission to rotate in a direction opposite to engine rotation. Two sliding gears on the output shaft of the forward transmission mesh with countershaft gear to provide a total of four speed positions. When the direction gear shift lever is moved to the reverse position, the sliding gear in the reversing transmission is shifted into engagement with the input shaft and rotates in the same direction as engine rotation.

a. Removal.

(1) Tilt seat back.

(2) Raise front of crane and block securely.

(3) Unscrew shifting lever caps and remove shifting levers.

(4) Disconnect clutch linkage beneath housing.

(5) Remove two universal joint companions between transmission and differential; remove drive shaft.

(6) Remove two transmission support bolts that secure support to frame.

(7) Raise and block front end of engine at least two inches above transmission support.

(8) Remove eight cap screws from transmission clutch bell housing.

(9) Slide transmission forward and turn crosswise.

(10) Lower transmission to ground and remove from crane.

b. Installation.

(1) Position transmission beneath crane, remove blocking and lower engine into line, and install eight cap screws in clutch bell housing; tighten all cap screws finger-tight; then tighten securely, proceeding from the center at top and then from left to right to the bottom.

(2) Install two transmission support bolts in transmission support and tighten securely.

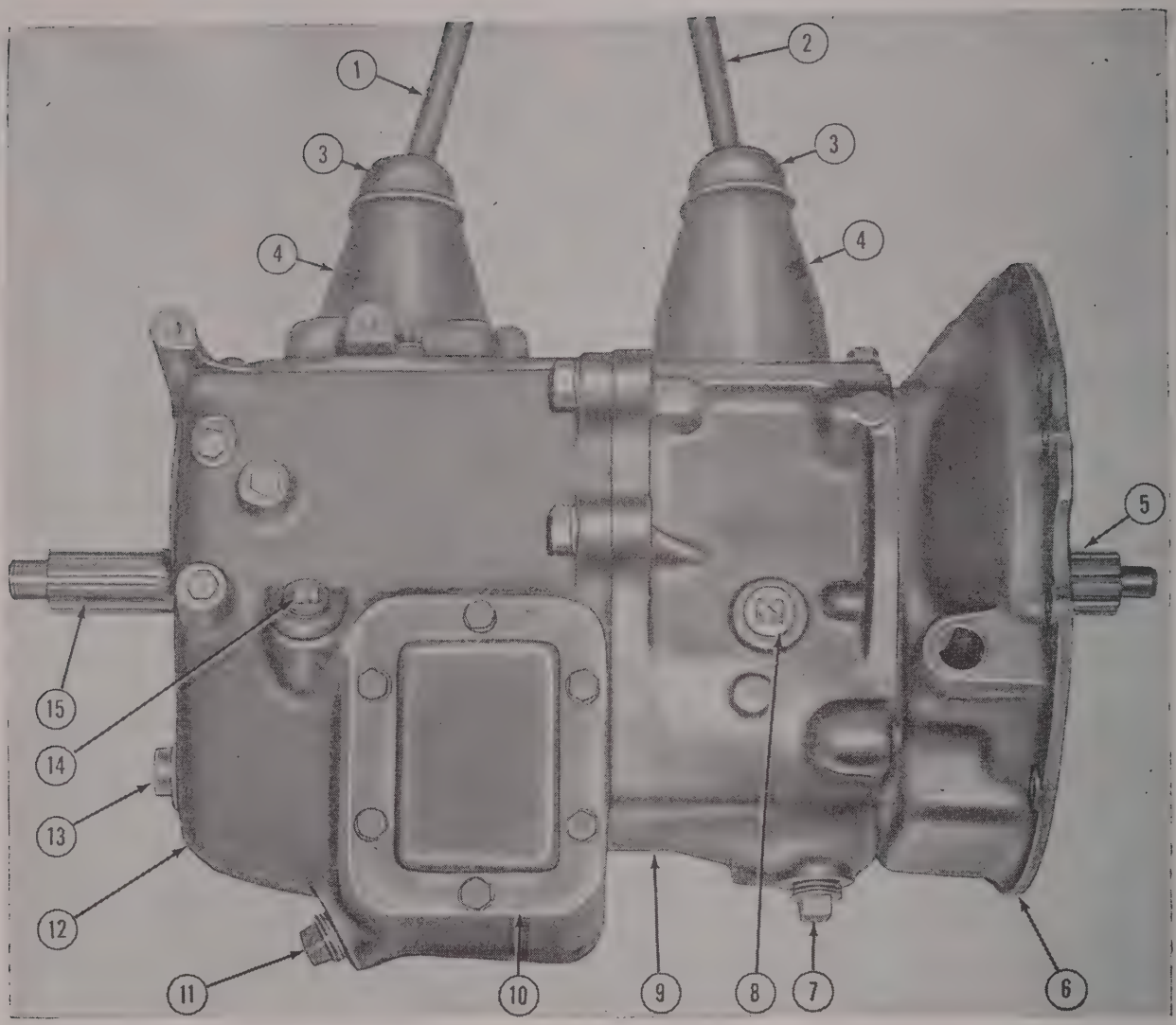
(3) Position drive shaft and install two universal joints connecting shaft to transmission and differential.

(4) Connect clutch linkage beneath housing.

(5) Install shifting levers and tighten lever caps securely.

(6) Remove blocking from beneath crane and lower crane to floor.

(7) Lower seat and operate shifting levers in all positions to check for proper functioning of clutch and transmission.



1 Four-speed shift lever
2 Forward-reverse shift lever
3 Shift lever locking caps
4 Shift lever tower castings
5 Input shaft and main gear
6 Transmission clutch bell housing
7 Forward-reverse transmission drain plug
8 Forward-reverse transmission filler plug
9 Forward-reverse transmission case
10 Transmission power take-off port
11 Four-speed transmission drain plug
12 Four-speed transmission case
13 Countershaft
14 Four-speed transmission filler plug
15 Transmission output shaft

Figure 32. Power train transmission.

Section VII. DRIVE AXLE ASSEMBLY

69. Overall Unit

The drive axle assembly consists of the axle housing (differential carrier), drive axle shafts, drive wheel and brake assemblies, and the differential. The entire assembly provides full-floating, single-reduction, spur-to-bevel gear drive. The differential case, with riveted ring gear, is mounted on the front of the crane. Drive axle shafts are splined into differential side gears at one end and mounted on bearings in the crane side frame at the other. Pinions on the outside ends of the drive shafts engage gears on the inside of the drive wheels to cause the drive wheels to rotate on steel stub dead axles. The dead axles are integral with the crane frame. Power to drive the drive axles is transferred from the transmission output shaft

to the differential input shaft by a splined universal joint.

70. Drive Wheels

The drive wheels are of the solid-cast, pneumatic-tire type, with demountable tires. An internal ring gear is mounted on the inside circumference of each wheel. This internal gear meshes with the drive axle pinion to turn the wheel, which is mounted on roller bearings and revolves on a dead stub axle.

a. Removal. Refer to figure 33 and proceed as follows:

(1) Block up frame immediately behind fender of wheel to be removed.
(2) Remove fender by removing three cap screws at each end.
(3) Remove four cap screws and lock washers on wheel hubcap and remove cap.
(4) Remove cotter pin that secures bearing adjusting nut.
(5) Remove eight cap screws and drive off wheel seal clamps.
(6) Remove bearing nut, using wheel bearing socket wrench and lever.
(7) Place lift chains between tires and operate lift until lift chains are drawn tight, using suitable lift. Boom and load line of the crane may be used for this purpose.
(8) Pry wheel out from frame until clear of dead axle, using pry bar or suitable timber.
(9) Lower wheel to working surface.

b. Installation.

(1) Raise wheel from working surface and position for installation on dead axle; seat wheel securely on dead axle.
(2) Rock wheel to engage teeth of final drive gear (drive axle pinion) and teeth of final driven gear (drive wheel internal ring gear).
(3) Install bearing adjusting nut and tighten securely with socket wrench.
(4) Install wheel seal clamps and tighten eight cap screws securely.
(5) Install new cotter pin in bearing adjusting nut.
(6) Position wheel hubcap; insert four holding cap screws; tighten securely.
(7) Install fender; tighten all cap screws securely.
(8) Remove lift chains from drive wheel; remove blocking from beneath frame and lower crane to working surface.

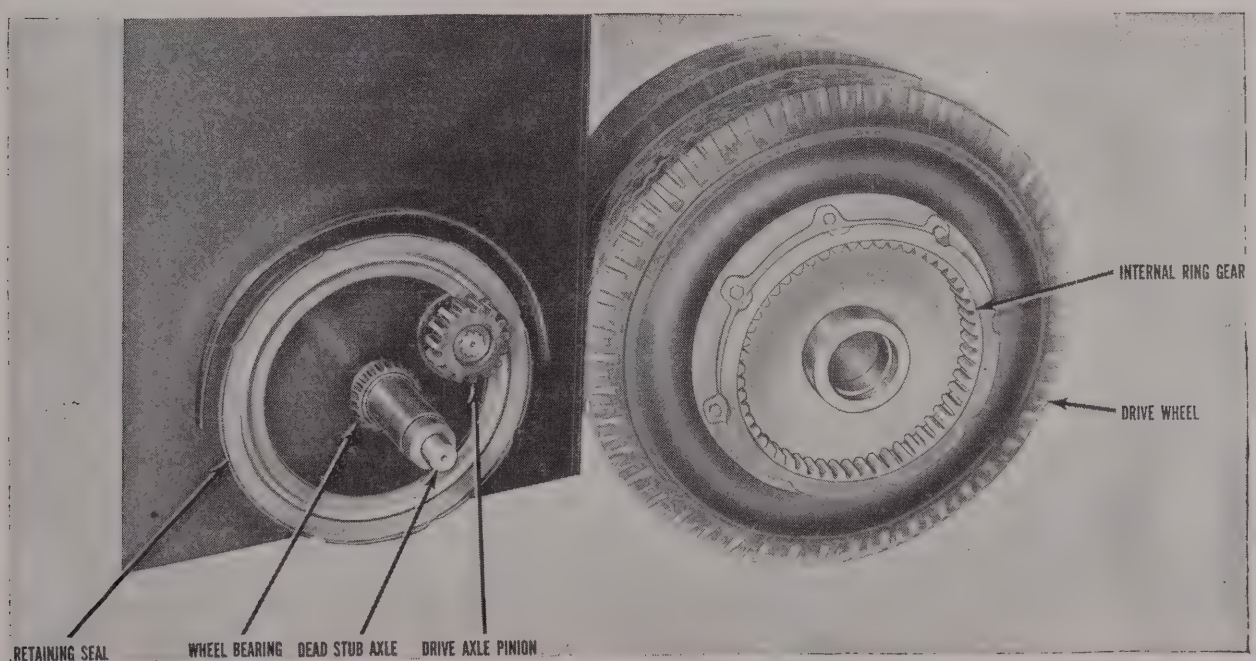


Figure 33. Removing drive wheel.

71. Axle Shafts

The drive axle shafts may be removed without disturbing the differential and case.

a. Removal.

(1) Remove drive wheels.
(2) Remove snap ring and final drive gear, using brake spring pliers and cotter key extractor.
(3) Remove wheel seal.
(4) Remove countersunk screw and two cap screws and washers that secure drive shaft bearing to frame.
(5) Remove snap ring that secures brake drum to drive axle spline on inside of crane frame, using two cotter key extractors.
(6) Replace final drive gear on drive axle shaft and reinstall snap ring on end of drive axle shaft.
(7) Insert pry bar between gear and crane frame and pry out drive axle asembly from frame.
(8) Remove bearing retainer and self-alining bearing from axle shaft.

b. Installation.

(1) Install drive axle bearing and drive in shaft. Station assistant beneath crane to aline splines on drive axle shafts with splines at center of brake drum.
(2) After splines are properly engaged and shaft has been driven all the way in, assistant may then install snap ring on shaft to secure brake drum.
(3) Reinstall bearing retainer with two cap screws and setscrew. Tighten securely.
(4) Reinstall wheel seal.
(5) Reinstall final drive gear and secure with snap ring.
(6) Reinstall drive wheels.

72. Differential

The differential and case form the center of the drive axle assembly. The differential consists of spider pinion and opposing beveled side gears which rotate on roller bearings. The side gears engage the splines on the inside ends of drive axle shafts to turn the drive wheels.

a. Removal.

(1) Remove drive wheels.
(2) Remove drive axle shafts.
(3) Secure differential housing to guide shift brackets under turntable with chains.
(4) Block differential housing securely on cross members beneath transmission housing and at base of crane front section.
(5) Remove four nuts and bolts that secure universal joint to companion flange.
(6) Remove cap screws that hold differential housing to frame.
(7) Remove blocking, lower differential housing to floor, and place on suitable workbench.

b. Installation.

(1) Position differential on blocking and drive in axle shafts to hold differential in place. Make sure that splines are matched before driving in axle shafts.
(2) Install companion flange on universal joint with four nuts and bolts and tighten securely.
(3) Install cap screws bracketing differential housing to crane frame and tighten securely.
(4) Complete installation of drive axle shafts and drive wheels.

Section VIII. STEERING SYSTEM

73. Overall Unit

The steering system consists of the steering gear and handwheel; the worm and worm gear case assembly; connecting linkage; the steering axle assembly; and the steering wheels. When the steering handwheel is turned, the linkage between the steering gear case and the worm and worm gear case (mounted just behind the driver's seat) causes a worm, turning within the worm gear case, to mesh with a gear splined to the steering axle vertical spindle and turn the steering wheels.

74. Steering Gear

The steering gear is the beveled reduction type, with steering gear case located at the base of the steering column. A bevel pinion on the end of the steering shaft is meshed with a beveled gear keyed to the steering output shaft. When the steering handwheel is turned, the bevel pinion on the steering shaft rotates the steering output shaft

to move connecting linkage and control the position of the steering wheels.

a. Removal.

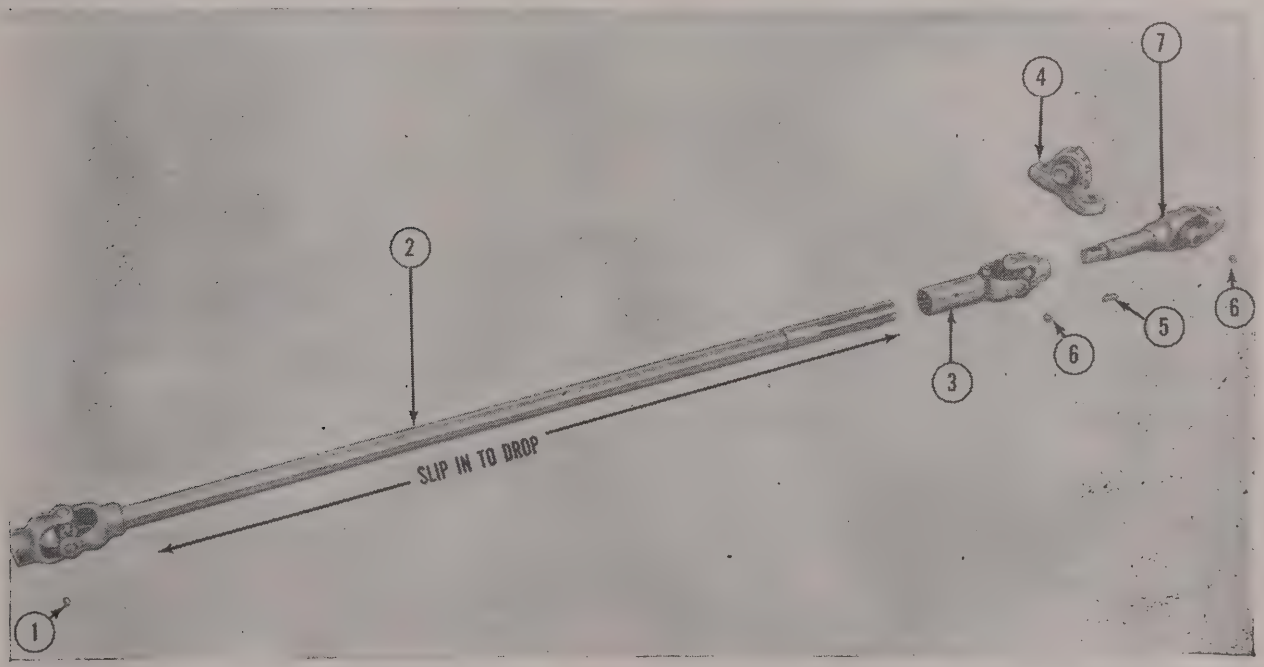
(1) Remove boom sluing control lever.
(2) Disconnect clutch pedal linkage at clutch pedal.
(3) Disconnect master cylinder linkage at brake pedal.
(4) Remove six cap screws from towboard and lift towboard up and off.
(5) Remove two cap screws that secure steering gear to mast support frame.
(6) Remove nut and bolt at base of gear case support bracket.
(7) Loosen setscrew on steering shaft universal joint.
(8) Pull gear case and column from engagement with universal joint; remove from crane as a unit.

b. Installation.

(1) Lower steering gear assembly into position and install steering output shaft universal joint. Tighten setscrew securely.
(2) Install bolt and nut on base of gear case support bracket; tighten nut until installation is secure.
(3) Install and tighten two cap screws mounting steering gear case to mast support frame.
(4) Position towboard and install six cap screws; tighten securely.
(5) Connect master cylinder linkage to brake pedal, using new cotter pin.
(6) Connect clutch pedal linkage to clutch pedal, using new cotter pin.
(7) Install boom sluing control lever.
(8) Check boom sluing mechanism and steering gear for proper operation.

75. Steering Linkage

The steering linkage (fig. 34) between the bevel gear steering case and the worm and worm gear sector case consists of the universal joints and stub shafts, which are integral; the steering intermediate shaft, which is welded to a universal joint at the steering case end and splined to a universal joint at the other end; the steering jackshaft, which is welded to a universal joint at the worm and sector case; and the pillow block, which guides and supports the jackshaft. The jackshaft is attached to the steering intermediate shaft at one end and the steering worm shaft at the other.



1 Steering output shaft universal joint setscrew
2 Steering intermediate shaft
3 Slip stub shaft
4 Pillow block
5 Jackshaft key
6 Jackshaft setscrews
7 Steering jackshaft

Figure 34. Steering linkage—exploded view.

a. Removal.

(1) Remove setscrew from universal joint yoke at steering output shaft.

(2) Move intermediate shaft toward rear of crane until universal joint is free of output shaft.

(3) Move intermediate shaft toward front of crane to disengage splines from stub shaft of universal joint at pillow block.

(4) Remove intermediate shaft.

(5) Remove setscrew and remove slip stub shaft universal joint assembly at pillow block.

(6) Remove two cap screws and remove pillow block.

(7) Remove setscrew from jackshaft universal joint end and remove jackshaft from engagement with worm shaft in worm and worm gear sector housing.

b. Installation.

(1) Install jackshaft universal joint yoke on worm shaft and secure with setscrew.

(2) Slide pillow block on shaft; position pillow block on frame top plate, and secure with two cap screws.

(3) Install slip stub shaft universal joint yoke on end of jackshaft and secure with setscrew.

(4) Install splined end of intermediate shaft in slip joint splined end; push shaft in as far as it will go.

(5) Position universal joint yoke at other end of intermediate shaft for installation on end of steering gear output shaft, matching keyway on yoke with key on output shaft. Install yoke on output shaft and lock in place with setscrew.

(6) Install setscrew in slip joint splined end to secure rear end of intermediate shaft in place.

76. Worm and Worm Gear Case Assembly

The worm and worm gear case assembly consists of the housing; the worm steering shaft; the worm gear, which is keyed to the steering shaft; the worm gear sector, which is splined to the vertical spindle on the steering axle to turn the wheels; and a spacer which locks the worm gear in line to mesh with and turn the worm gear sector.

a. Removal.

(1) Remove setscrew from universal joint connected to worm shaft and slide joint toward the front of the crane until it clears the worm shaft.

(2) Remove cap screws and remove cover plate.

(3) Remove six cap screws and slide end cover away from housing to provide play in worm shaft.

(4) Remove gear sector.

(5) Remove six cap screws securing lower part of housing to crane top plate.

(6) Remove worm and worm gear case assembly.

b. Installation. Reverse procedure in *a* above.

77. Steering Wheels

The steering wheels are the pneumatic-tired, formed-disk type, and rotate on adjustable tapered roller bearings. No adjustment for camber is provided.

a. Removal.

(1) Raise crane with jack until wheels barely clear working surface.

(2) Remove six nuts from wheel hub studs.

(3) Remove wheel.

b. Installation. Reverse procedure in *a* above.

78. Steering Axle Assembly

The steering axle assembly consists of the vertical spindle, on which the axle is mounted; the axle, which includes the saddle box and stub axles; and the wheel hubs, which house the stub axles and wheel bearings. As stub axles are pressed into saddle box and lightly welded, no attempt should be made to remove the axles from the saddle box except where depot maintenance equipment is available.

a. Removal.

(1) Remove steering wheels.

(2) Remove hinge pin cap screw and drive out hinge pin.

(3) Jack up crane until saddle box is clear of vertical spindle end.

(4) Remove axle from beneath crane.

(5) Remove eight cap screws and washers and remove worm and worm gear housing cover plate.

(6) Remove six cap screws and washers and slide worm gear housing end plate away from housing to provide necessary play in worm shaft to disengage worm and worm sector.

(7) Lift out worm gear sector.

(8) Remove top lock nut, externally toothed washer, and bottom lock nut from vertical spindle.
(9) Tap spindle out through bottom of crane, using lead hammer.

b. Installation.

(1) Install vertical spindle, reversing (5) through (9) above.
(2) Position axle assembly beneath crane with saddle box hinge holes in line with holes in vertical spindle end.
(3) Lower crane until holes are in line; insert pin and secure with cap screw.
(4) Install steering wheels.

Section IX. BRAKES

79. Service Brakes

The service brakes are the two-shoe, foot-operated, hydraulic type with drum cylinders and brake shoe assemblies (fig. 35), located on both drive axles to brake the drive wheels. The drums are splined to and turn with the drive axle shafts; the brake assemblies are rigidly mounted on the crane frame. Snap rings prevent lateral motion of the drums and hold them in place around the brake shoe assemblies.

a. Removal.

(1) Remove drive wheel.
(2) Remove axle shaft.
(3) Remove four cap screws that secure brake backing plate to side frame.
(4) Disconnect linkage at hand brake lever.
(5) Remove brake shoe assembly from frame.
(6) Press against actuating lever until hand brake cable is loose and may be pulled from the recess in the end of the lever.

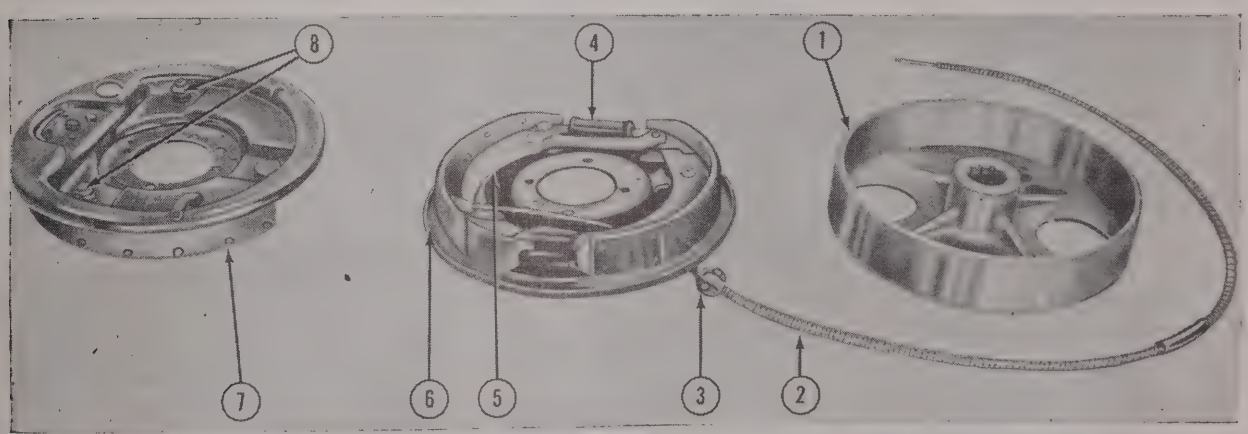
b. Installation.

(1) Install hand brake cable in actuating lever recess and tap end of lever until cable is securely installed and will not slip out of place.
(2) Position brake backing plate and shoe assembly against side frame; install four cap screws and tighten until backing plate is securely mounted.
(3) Connect hand brake linkage to hand brake lever.
(4) Install axle shaft.
(5) Install drive wheel.

80. Brake Shoes and Linings

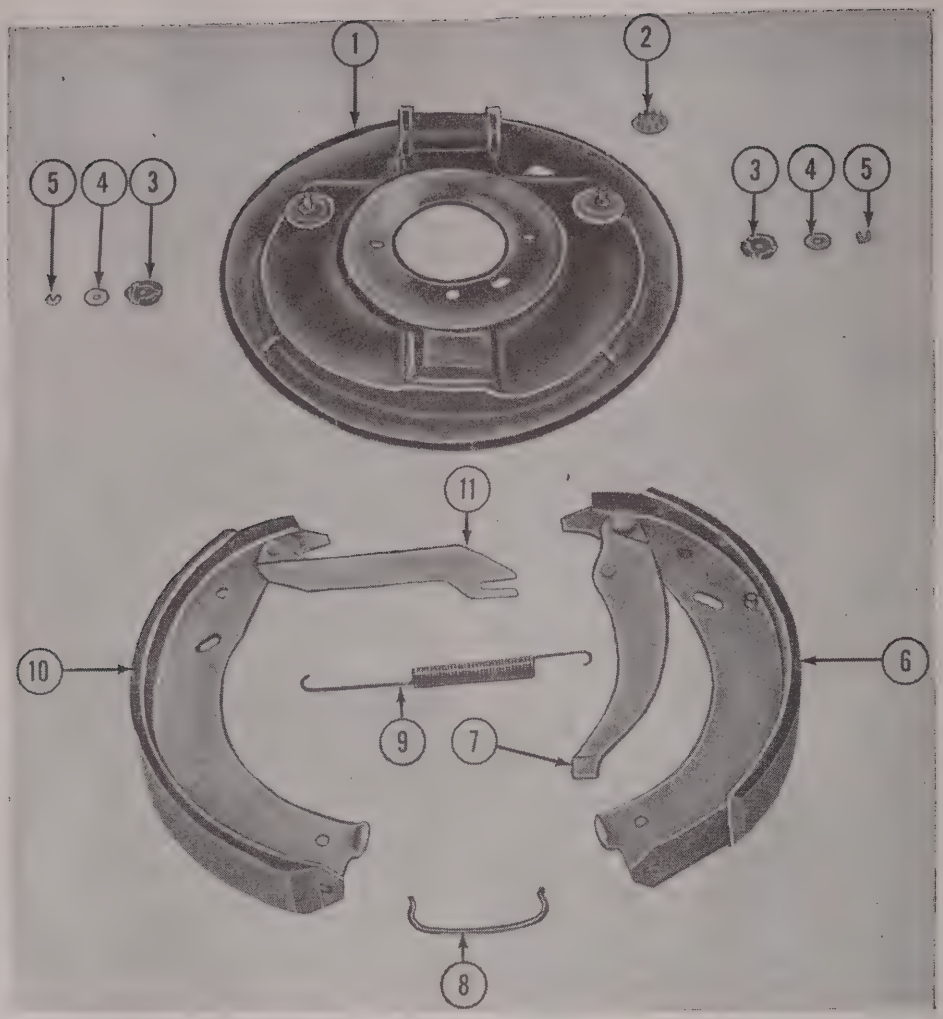
a. Removal. Refer to figure 36 and proceed as follows:

(1) Remove drive wheel.
(2) Remove drive axle shaft.
(3) Remove brake backing plate from crane side frame.
(4) Disconnect parking brake cable and remove from parking brake lever slot.
(5) Remove brake return spring using brake spring pliers.
(6) Remove C washers and washers from shoes.



1 Brake drum
2 Parking brake cable
3 Parking brake cable stop clamp
4 Wheel cylinder
5 Parking brake actuating lever
6 Backing plate
7 Brake shoe
8 Adjusting cam and shoe guide studs

Figure 35. Service brake units.



1 Brake backing plate assembly
2 Inspection cover
3 Antirattle spring washer
4 Shoe guide plain washer
5 Shoe guide C washer
6 Rear shoe and lining
7 Parking brake lever and pin assembly
8 Brake shoe anchor spring
9 Brake shoe retracting spring
10 Front shoe and lining
11 Parking brake shoe link and pin

Figure 36. Wheel brake assembly.

(7) Pull parking brake lever toward center of backing plate and slide shoe and lining assembly off shoe heel block.
(8) Remove anchor spring.
(9) Remove nut and washers from parking brake lever pivot and separate shoes.
(10) Remove rivets and linings from shoes.

b. Installation.

(1) Wash brake shoes thoroughly in dry cleaning solvent.
(2) Install linings on shoes and secure with rivets; make sure that rivet heads are countersunk below surface of linings. Reline shoes on both wheels at the same time, using identical lining for both.
(3) Install parking brake lever on pivot pin and secure with nut and washers.
(4) Install brake anchor spring and position shoes with heels set in slots in heel block.
(5) Install washers and C washers to secure shoes to backing plate.
(6) Install brake return spring using brake spring pliers.
(7) Install parking brake cable in parking brake lever slot and tamp heel of lever down with soft hammer, to secure.
(8) Install brake backing plate to crane side frame and tighten cap screws securely.
(9) Install drive axle shaft.
(10) Install drive wheel.

81. Wheel Cylinders

a. Removal.

(1) Install brake cylinder clamp, remove brake shoe return spring, and spread shoes until clear of brake cylinder.

(2) Disconnect fluid line at wheel cylinder.

(3) Remove two cap screws securing cylinder to backing plate and remove cylinder.

b. Installation.

(1) Position wheel cylinder on brake backing plate; install two cap screws and tighten until cylinder is securely mounted.

(2) Install brake fluid line to wheel cylinder inlet and tighten fitting securely.

82. Master Cylinder

The master cylinder (fig. 37) is the conventional type. It is equipped with a switch which causes the taillight to operate when the service brake petal is depressed.

a. Removal.

(1) Remove master cylinder outlet line from cylinder fitting and drain cylinder.

(2) Remove battery and taillight wires from taillight switch.

(3) Disconnect push rod linkage at brake pedal.

(4) Remove two cap screws and washers that secure cylinder to mounting bracket.

b. Installation.

(1) Position master cylinder on mounting bracket and install washers and cap screws. Tighten cap screws until cylinder is rigidly mounted.

(2) Connect push rod linkage to brake pedal.

(3) Install battery and taillight leads on taillight switch. Make sure connections are clean and tight.

(4) Install master cylinder outlet line on cylinder fitting; tighten securely.

(5) Fill master cylinder to proper level with prescribed hydraulic fluid.

(6) Test brakes for proper performance and observe operation of taillight.

83. Hand Brakes

The hand brakes provide individual braking of drive wheels. Hand brake levers are located on opposite sides of the mast support frame and are connected to service brake assemblies by steel cables. The cables are passed through the hand brake lever arms and attached to the lever knobs. Knobs may be moved up or down on the threaded ends of the levers to obtain proper adjustment in the hand brake linkage.

a. Removal.

(1) Remove three bolts that support hand brake lever housing.

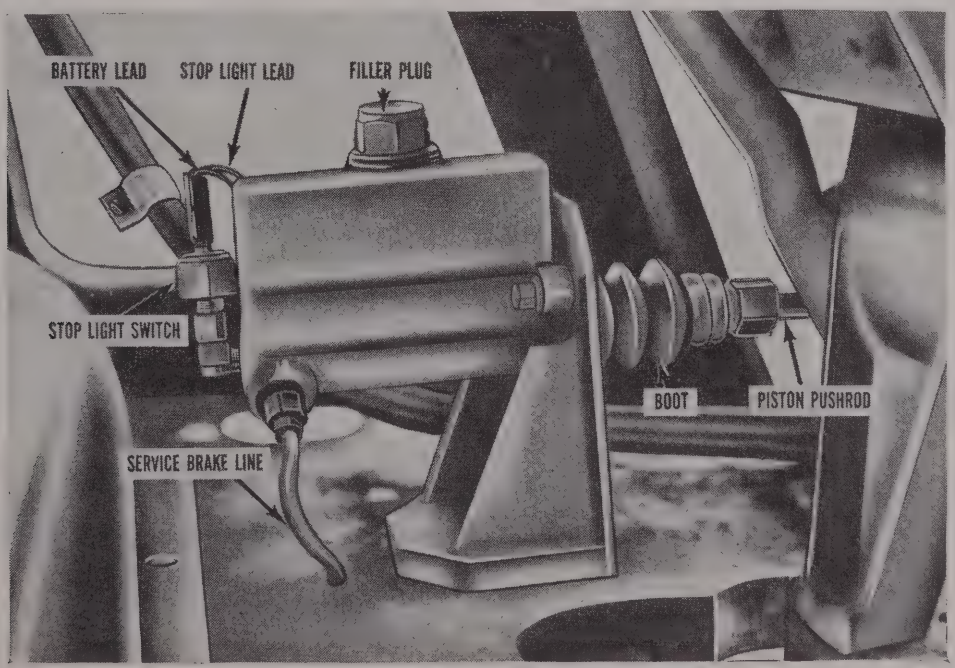


Figure 37. Brake master cylinder.

(2) Remove cable clamping bolt at lower end of lever housing.
(3) Remove clevis pin and cotter key in frame slide and remove hand brake assembly.

b. Installation.

(1) Position hand brake assembly and install clevis pin and cotter key in frame slide.
(2) Install cable clamping bolt in lower end of lever housing and tighten securely.
(3) Install three bolts that secure hand brake housing to mast support frame and tighten securely.

Section X. WHEELS AND TIRES

84. Wheel Alinement

The factors involved in steering wheel alinement on this crane are camber, the outward tilt of the steering wheels at the top and toe-in, the inward tilt of the steering wheels at the bottom. As the position of the crane steering axle is fixed and no adjustment is provided to offset camber or toe-in, steering difficulties such as hard steering, wander, side pull, or shimmy may be attributed to other components of the steering system. If camber or toe-in is present, inclination of wheels may be caused by excessive tire wear. This condition may be corrected to a limited extent by reversing the position of the tires. However, the entire steering system should be carefully inspected when steering difficulties are present.

85. Tire Replacement

Steering and drive wheels are equipped with pneumatic tires. The steering tires are 7.50 x 15, 10-ply; tread is 9 45/8 inches. The driving wheel tires are 9.00 x 20, 12-ply, and have a tread of 126 1/2 inches. Both drive wheel and steering wheel tires are mounted on demountable rims.

Section XI. POWER TAKE-OFFS

86. Main Power Take-Off

The main power take-off is a multisheaved pulley mounted on the rear end of the crankshaft. Belts from this pulley drive the fan, the load hoist winch, and the boom topping winch. The main power take-off turns with the crankshaft to drive the side power take-offs and transfer power to the crane winches. The main power take-off pulley is mounted on the crankshaft adapter and may not be removed without first removing the engine.

a. Removal.

(1) Loosen fan frame mounting cap screws and lower fan frame. Remove fan drive belt from main power take-off pulley.
(2) Loosen side power take-off pulleys and remove drive belts from main power take-off pulley.
(3) Remove engine.
(4) Remove six Allen screws and remove pulley, using Allen wrench. Remove cap screw and washer and remove adapter, using gear puller.

b. Installation.

(1) Install adapter and tap into place, using soft mallet.
(2) Position washer and install holding cap screw in crankshaft. Tighten securely.
(3) Position pulley and install six Allen screws. Tighten finger-tight and then tighten all screws evenly and securely with Allen wrench.
(4) Install engine.
(5) Install drive belts on side power take-off pulleys and adjust to proper deflection.
(6) Install fan drive belt and place in tension by moving fan frame to desired position. Tighten fan frame mounting cap screws and adjust fan belt to proper deflection.

87. Side Power Take-Offs

The two side power take-offs, which are mounted at opposite sides to the rear frame of the crane and are identical in design, drive the boom topping winch and the load hoist winch. The side power take-offs are driven pulleys mounted on stub shafts, and rotate on ball bearings. Belts from the main power take-off drive these pulleys to transfer power to the winches through universal joints and shafts. Adjustment of pulleys for removal of belts is provided.

a. Removal.

(1) Remove four cap screws that secure pulley mounting bracket to crane frame.

(2) Remove drive belts from pulley.
(3) Remove U-bolt and remove universal joint propeller shaft hub from pulley drive shaft (fig. 38).
(4) Remove side power take-off pulley assembly.

b. Installation.

(1) Install drive belts on pulley sheaves.
(2) Position pulley mounting bracket on frame and install four cap screws. Tighten securely.
(3) Install universal joint propeller shaft on pulley drive shaft; tighten connecting U-bolt. Install setscrew in propeller shaft universal joint hub.
(4) Adjust side power take-off pulley drive belts to proper deflection.

88. Sluing Clutch Power Take-Off

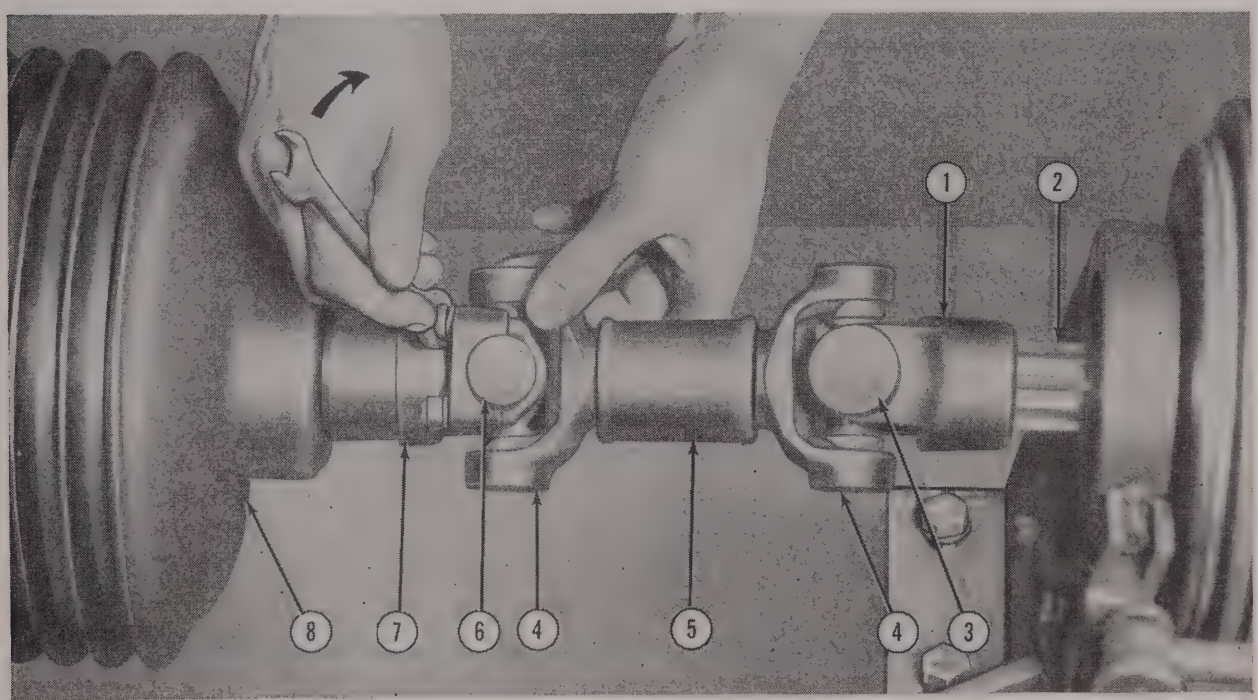
The sluing clutch is driven by a power take-off mounted just to the front of the load hoist winch and operated from the front end of the load hoist clutch drive shaft. Power is transferred from the pulley on the sluing clutch power take-off to a pulley mounted on the sluing clutch shaft by means of belts. These belts extend upward to the pulley mounted on the front of the sluing clutch drive shaft to swing the turntable.

a. Removal.

(1) Loosen three cap screws that secure power take-off bracket to side frame and move bracket up to release tension on sluing drive belts. Remove drive belts.
(2) Remove three cap screws.
(3) Remove setscrew from universal joint on output shaft and slide sluing power take-off assembly from engagement with universal joint splines.

b. Installation.

(1) Engage take-off pulley drive shaft splines with splines in universal joint on output shaft.
(2) Position power take-off assembly bracket and install three cap screws. Turn down cap screws just enough to engage threads.
(3) Install drive belts on pulley and slide bracket up or down on cap screws to obtain desired deflection in drive belts.
(4) Tighten three cap screws securely and install setscrew in universal joint hub to hold pulley shaft in position.



1 Splined input slip yoke
2 Winch input shaft
3 Splined input yoke cross bearing
4 Propeller shaft yoke
5 Propeller shaft sleeve
6 Power take-off slip yoke cross bearing
7 Power take-off slip yoke
8 Power take-off pulley

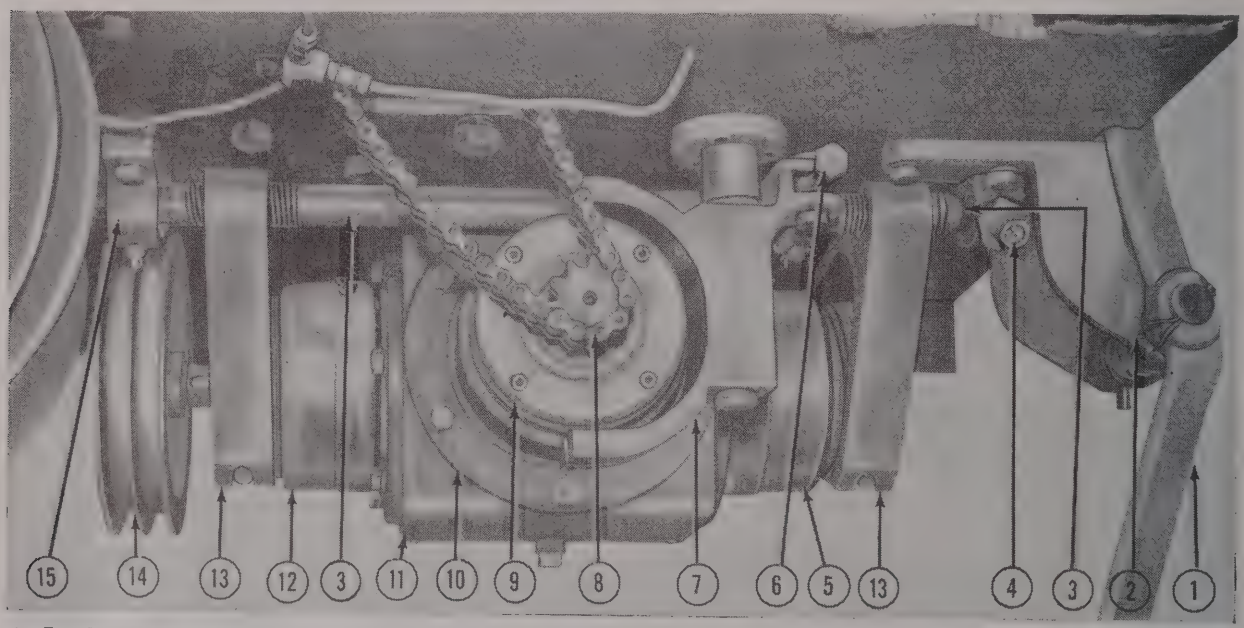
Figure 38. Removing U-bolt from propeller shaft assembly.

89. Sluing Clutch

The sluing clutch (fig. 39) is the friction-cone type and drives the turntable when engaged. Power to operate the clutch is provided from the pulley on the sluing power take-off assembly, which is mounted on the right side of the crane and is driven from the output shaft of the load hoist clutch. This pulley is connected to the pulley on the input shaft (front end) of the sluing clutch drive shaft by two drive belts. A drive pinion extending from the clutch housing drives the turntable by means of a chain, which is mounted on the drive pinion, and a pinion on the turntable worm shaft. The sluing clutch is of the same type as the boom topping and load hoist clutches. A third clutch, which acts as a brake for the turntable, is mounted on the sluing clutch output shaft. When the turntable has been swung 95° to either side, the turntable stops cause a safety rod to throw the sluing clutches into a neutral position and the sluing brake facing to be thrown into engagement to hold the turntable in a fixed position.

a. Removal.

(1) Remove turntable assembly.
(2) Remove drive belts.
(3) Remove chain link pin cotter key and link pin, and remove drive chain.
(4) Remove top and bottom cotter keys and remove brake throwout bearing yoke mounting pin.
(5) Remove three cap screws and washers located just to right of master cylinder mounting bracket on turntable plate and remove throwout bearing yoke assembly.
(6) Remove cotter key and clevis pin from safety rod clevis.
(7) Remove zerk fitting from pillow block on front end of shifter shaft.
(8) Loosen two cap screws on pillow block.
(9) Remove jam nut on shifter lever bracket poppet and hold hand beneath poppet to catch spring and ball as they drop.
(10) Remove cotter key and clevis pin from forward end of shifting lever bracket.
(11) Remove three cap screws and washers that secure shifting lever bracket to top



1 Load hoist winch operating lever
2 Sluing control lever mounting bracket
3 Sluing shifter shaft
4 Sluing shifter shaft centering poppet
5 Left sluing clutch
6 Sluing brake adjusting screw
7 Sluing brake yoke and yoke support
8 Sluing output drive pinion and chain
9 Sluing brake throwout bearing assembly
10 Sluing brake housing
11 Sluing transmission case
12 Right hand sluing clutch
13 Sluing shifter yokes
14 Sluing input shaft drive pulley
15 Sluing shifter shaft pillow block

Figure 39. Sluing clutch and transmission.

plate and remove bracket by sliding to rear.

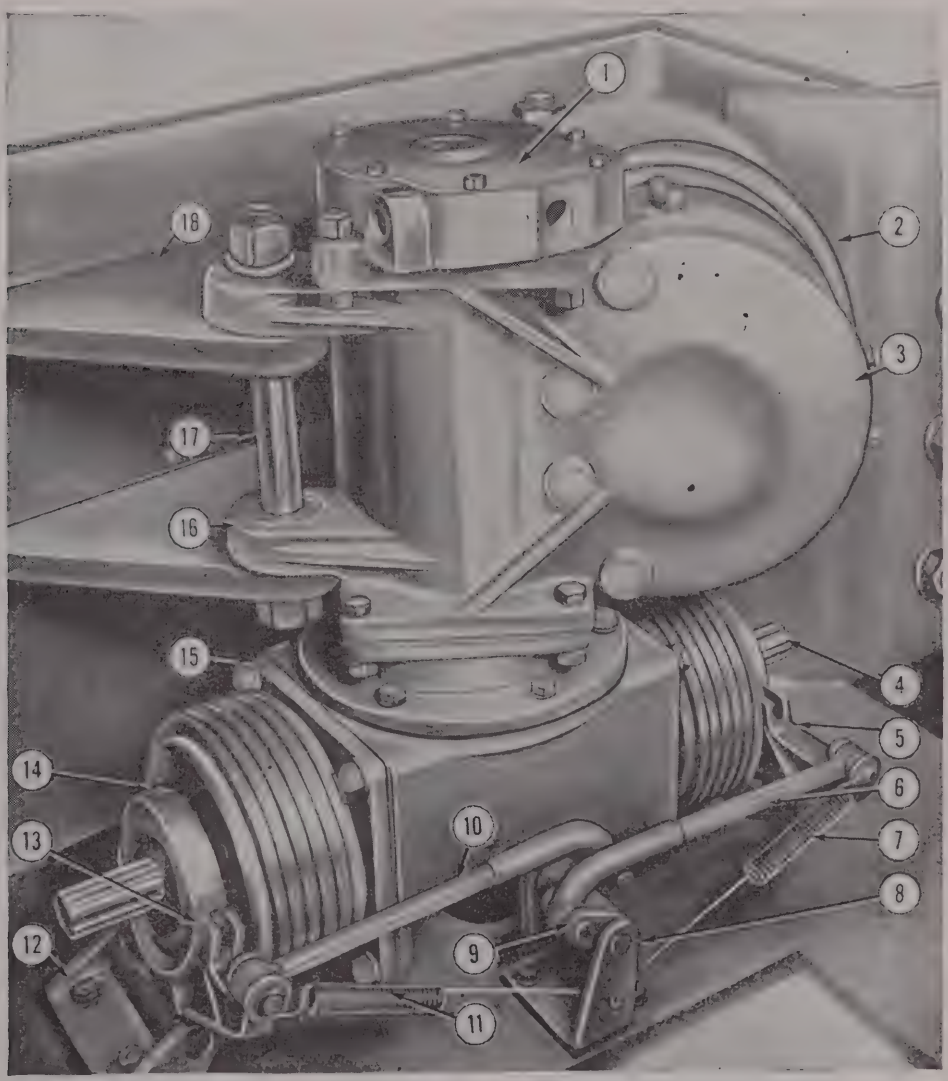
(12) Remove two cap screws from pillow block and remove shifter shaft and fork assembly.

(13) Remove three cap screws and washers just inside mast support bracket and drop sluing transmission and brake assembly.

b. Installation. Reverse procedure in *a* above.

90. Boom Topping and Load Hoist Clutches

The boom topping and load hoist clutches (fig. 40) control the operation of the boom topping and load hoist winches. Clutches are the friction-cone, self-compensating type, and are controlled by linkage from their respective shifting levers. Two clutches are employed in the operation of each winch; one to cause the winch drum to move forward and release cable, and the other to cause the winch drum to turn in the opposite direction



1 Winch brake housing
2 Winch drum
3 Winch worm and worm gear case
4 Transmission drive shaft
5 Raising clutch yoke
6 Raising clutch shifter arm
7 Raising clutch return spring
8 Central pivot mounting bracket
9 Central pivot winch shifter
10 Lowering clutch shifter arm
11 Lowering clutch return spring
12 Shifter yoke mounting bracket
13 Lowering clutch yoke
14 Lowering clutch throwout bearing
15 Transmission case
16 Winch inboard bearing
17 Winch mounting rod
18 Winch inboard bearing mounting bracket

Figure 40. Winch and clutch, control linkage at pivot assembly.

and take up cable. When the control lever is shifted, attached linkage moves the clutch shifter arm assembly on a centrally located pivot to engage one clutch and disengage the other. The clutches are in two halves: the drive half, which is splined to the clutch drive shaft, and the driven half, which has a bevel drive pinion secured to its hub with dowel pins and cap screws. This drive pinion rotates with the driven clutch half to drive the winch bevel drive gear, with which it is in constant mesh. Clutch driven half facings are of molded friction lining material and are not replaceable.

a. Removal.

(1) Remove sluing drive bracket assembly if load hoist winch is to be removed.

(2) Remove drain plug and drain lubricant from base of clutch, reversing transmission case.

(3) Remove cotter key and clevis pin and disconnect linkage from shifter pivot assembly.

(4) Remove raising (forward) clutch driving half and throwout bearing from clutch drive shaft.

(5) Remove driven half of raising clutch (fig. 41), using gear puller.

(6) Remove two U-bolts from yoke of universal joint drive assembly at power take-off pulley. Tap lightly on universal joint assembly until it will slide from power take-off end, using a soft hammer.

(7) Push universal joint assembly toward winch as far as splines will permit.

(8) Lower loose end until it will clear yoke on power take-off pulley.

(9) Remove universal joint from splined winch input shaft.

(10) Remove lowering clutch driving half and throwout bearing.

(11) Remove driven half of lowering clutch, using gear puller.

b. Installation.

(1) Drive driven half of clutch into place with a soft mallet, using the dowel pins as a guide.

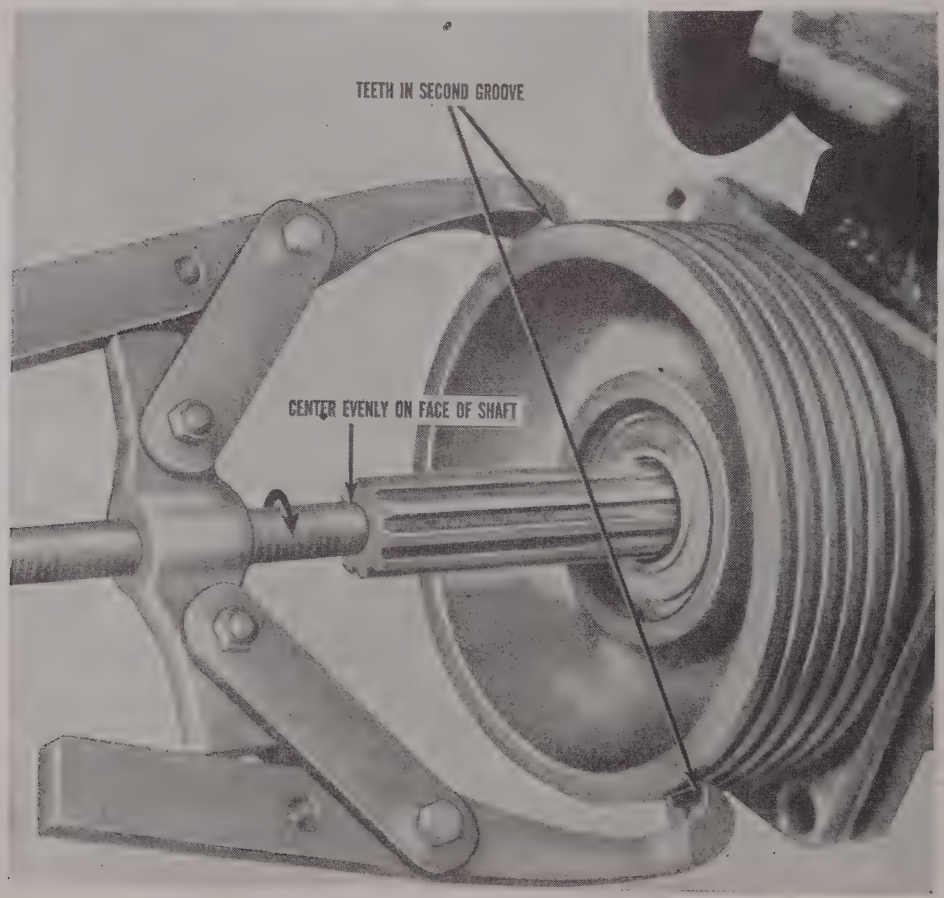


Figure 41. Removing clutch driven half.

(2) Install lowering clutch throwout bearing.
(3) Install universal joint on splines of winch input shaft. Move joint toward winch as far as possible.
(4) Move loose end into position for installation of U-bolts on universal joint yoke at power take-off assembly.
(5) Install U-bolts and tighten nuts securely.
(6) Drive in the raising clutch driven half with a soft mallet, using dowel pins as a guide.
(7) Install driving half of raising clutch; install throwout bearing.
(8) Install linkage to shifter pivot assembly. Use new cotter pin to secure.
(9) Install sluing drive bracket assembly, if load hoist winch is being installed. Adjust drive belts to proper deflection.
(10) Fill clutch reversing transmission case to prescribed level and install drain plugs. Tighten drain plugs securely.
(11) Test operation of clutch and adjust if necessary.

Section XIII. LOAD HOIST AND BOOM TOPPING WINCH ASSEMBLIES

91. Winches

The load hoist and boom topping winches are identical in construction. Each winch consists of two units: the winch worm shaft assembly, which is turned by the clutch shaft bevel drive pinion at one end and the winch worm and worm gear drive assembly, which consists of a worm gear and drum, keyed to a shaft, which is driven by the worm on the worm gear shaft to rotate the winch drums. The winch worm and worm gear case contains both units. This case is seated on the clutch reversing transmission housing at the bottom and secured to the frame on special mounting brackets.

a. Removal.

(1) If removing load hoist winch, remove engine manifold assembly and sluing drive bracket assembly and belts.
(2) Remove fuel tank.
(3) Disconnect cable from boom.
(4) Wind cable on winch drum. When cable has been taken in completely, wire end of cable to one of the turns on the drum so that it will not hang loose in disassembly.
(5) Remove winch brake operating linkage at lever and winch ends by removing cotter keys and clevis pins.
(6) Remove six machine screws holding cable guard halves together.
(7) Remove two cap screws that secure cable guard to sheave guard beneath mast.
(8) Remove two cap screws that secure cable guard to frame bracket; remove cable guard.
(9) Loosen three mounting bolts on voltage regulator and remove regulator.
(10) Disconnect winch clutch linkage from operating lever and shifter pivot assembly.
(11) Disconnect winch drive assembly at side power take-off by removing two U-bolts from universal joint yoke. Tap lightly on universal joint assembly, forcing it to separate from power take-off end, using a soft hammer.
(12) Push universal joint assembly toward winch as far as splines will permit.
(13) Lower loose end until it will clear yoke on power take-off pulley shaft.
(14) Remove universal joint from splined shaft.
(15) Remove three mounting cap screws from side power take-off pulley mounting assembly, and slide propeller shaft assembly off end of winch input shaft.
(16) Remove two cap screws from shifter yoke positioning support.
(17) Remove shifter adjusting arms from both ends of winch by removing cotter pins and clevis pins.
(18) Remove mounting cap screws from shifter pivot bracket.
(19) Remove shifter yokes and linkage.
(20) Loosen setscrew in outboard bearing and remove top and bottom nuts from outboard bearing support rod.
(21) Drive supporting rod down and out, using soft drift.
(22) Remove outboard bearing by pushing

from end of winch drum shaft.

(23) Place chains around and beneath winch assembly, using chain hoist. Make sure that chains are positioned in such a manner that the strain of lifting will not be assumed by housing castings. Do not place chains around winch drum only, although the drum may be used as a guide for the lift chain provided the chain is secured below the drum and not against the drum.

(24) Place lift chain in tension. Remove remaining winch supporting rod by removing nuts at each end and driving the rod from the bottom and out of the top of the outboard bearing.

(25) Loosen cap screws on toeboard and move toeboard up to clear winch drum on removal.

(26) Taking care not to damage engine accessories, move the winch inward from outboard bearings slowly until drum shaft clears bearing. Make sure that winch is clear of all obstructions before lifting from crane.

b. Installation. Reverse procedures in *a* above and adjust clutch, winch brakes, and sluing drive belts.

92. Winch Brakes

Each winch is equipped with a separate brake to hold the boom and the load line in position and prevent the load from slipping. The winch brakes automatically brake the winches whenever the winches are not in operation and shifting levers are in a neutral position. An adjustable rod connects each winch brake to the operating lever controlling the action of its respective winch. The brake remains in an open position while either clutch driven half is engaged. When the operating lever is returned to a neutral position, the brake band closes to hold the worm shaft motionless until the lever is shifted to again engage the clutch.

a. Removal.

(1) Remove six cap screws and brake housing cover.

(2) Remove snap ring from worm shaft at top of winch brake drum.

(3) Pry off brake drum and remove key from worm shaft.

(4) Remove adjusting nuts from ends of brake spring mounting rod and remove rod and spring.

(5) Unscrew brake cam mounting sleeve and remove brake cam.

(6) Remove brake band lock nut and remove brake band.

(7) Remove lock nut and remove brake band mount.

(8) Remove spanner nut from brake band mount.

(9) Remove remaining snap ring from top of worm shaft.

(10) Remove two cap screws and two bolts and nuts from flange of brake assembly housing and remove housing.

(11) Place brake assembly housing on workbench and drive out two oil seals.

b. Installation. Reverse procedure for removal in *a* above.

Section XIV. MAST, TURNTABLE ASSEMBLY, AND BOOM

93. Mast and Turntable Assembly

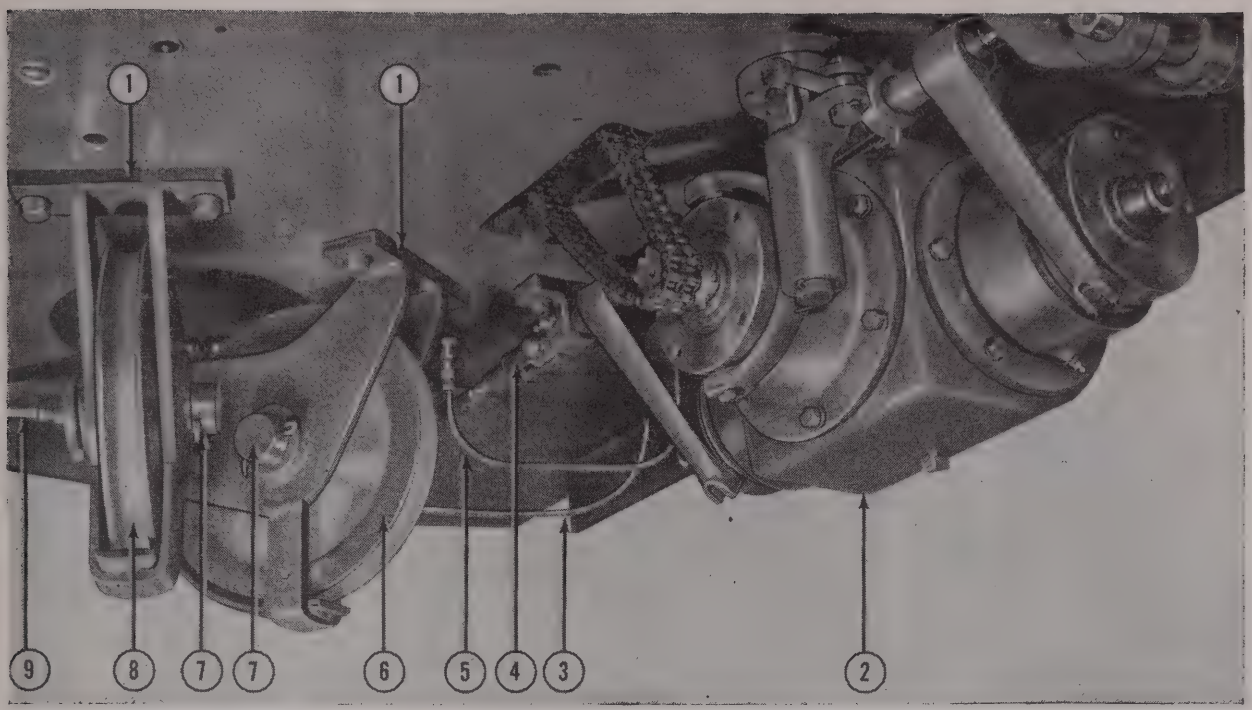
The mast and turntable assembly (figs. 42 and 43) consists of the mast, through which cables from the boom are passed to sheaves below and thence to the winch drums, and the turntable, which consists of the front top plate, the mast support bracket, and the worm and worm gear turntable assembly. The turntable assembly is driven by a chain from the sluing transmission output shaft pinion and will turn the boom 95° to the right or left. The sluing worm gear, on which the turntable rotates, is a single casting. The worm gear turns on radial thrust bearings in the earlier models of the crane and on roller bearings in the later models. Stops are provided on the bottom of the worm gear which brake the sluing transmission whenever the boom has been swung beyond the limit of 95° in either direction.

a. Removal.

(1) Remove boom and wind cables on drums.

(2) Disconnect gear shift levers at transmission cover and remove through bottom of crane.

(3) Disconnect load hoist and boom topping operating levers by removing cotter pins and clevis pins on linkage leading to winch clutches and winch brakes.



1 Mast base sheave bracket
2 Sluing transmission case
3 Load line sheave lubrication line
4 Boom sluing safety stop linkage
5 Lower sluing ball race lubrication line
6 Load line sheave
7 Sheave pins
8 Boom topping sheave
9 Boom topping sheave lubrication line

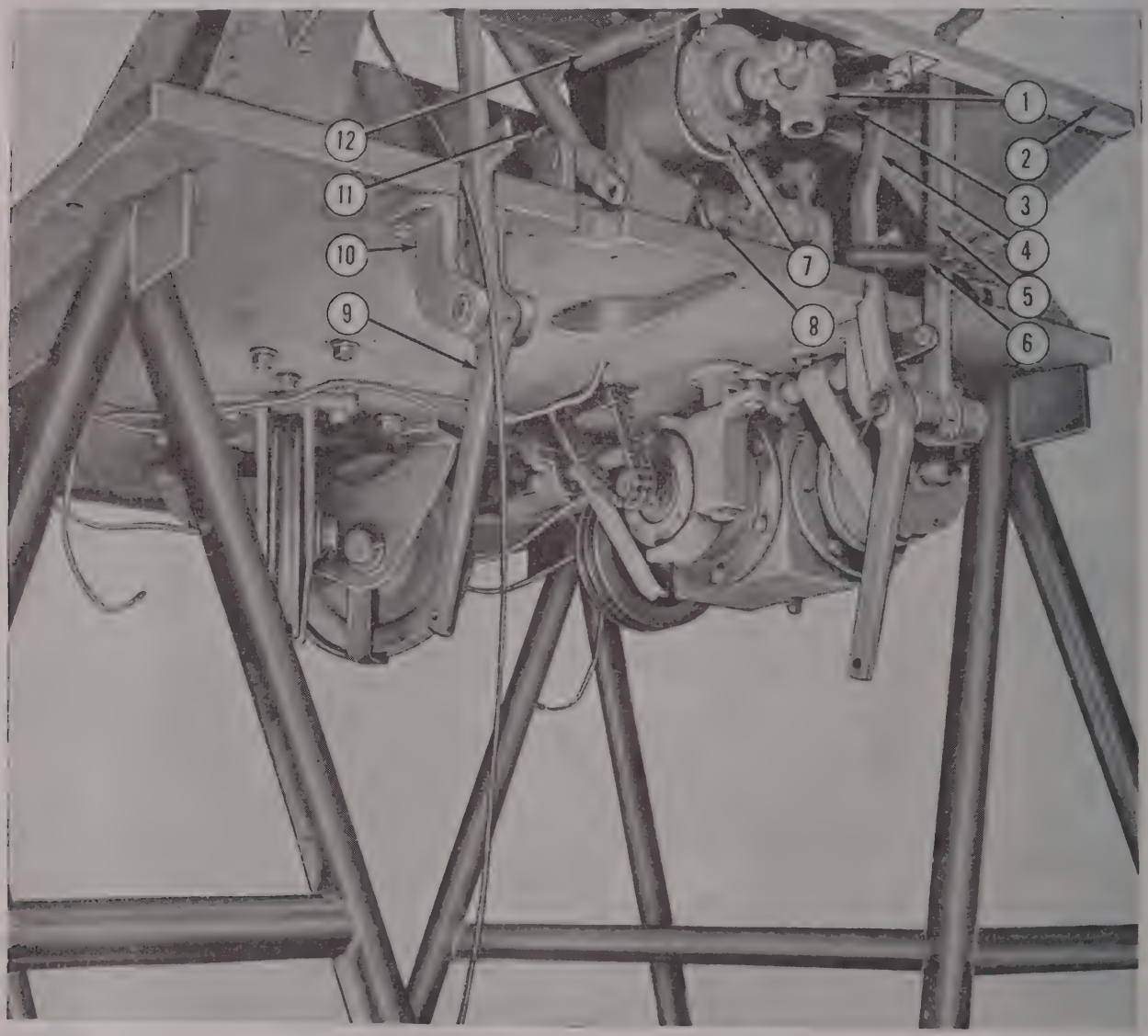
Figure 42. Mast base sheave bracket assembly.

(4) Remove Allen screws and hinge pin pivot levers on hinge brackets.
(5) Disconnect clutch pedal linkage at reach rod clevis.
(6) Disconnect cable guards from sheave yokes under mast.
(7) Disconnect all lubrication lines under turntable base.
(8) Disconnect hydraulic brake line at T fitting.
(9) Disconnect hand brake cables at mast.
(10) Disconnect accelerator pedal at ball and socket joint and disconnect hand throttle linkage.
(11) Disconnect choke cable at carburetor.
(12) Remove sluing drive belts.
(13) Loosen setscrew in steering intermediate shaft universal joint.
(14) Disconnect wiring at junction to rear of turntable.
(15) Remove 14 cap screws and lock washers that secure base of turntable to main frame.
(16) Slide table forward until steering intermediate shaft works out of universal joint, using lifting apparatus capable of lifting 1,500 pounds.
(17) Move turntable to suitable workbench slowly, checking to see if free of all connections to crane.

b. Installation.

(1) Position turntable and slowly lower into place; install 14 lock washers and cap screws and attach turntable base to crane frame securely.
(2) Connect all leads from turntable to plastic junction tubes. Be sure that wire colors are matched in junctions.
(3) Install intermediate shaft universal joint on steering gear output shaft and secure with setscrew.
(4) Install sluing drive belts and adjust to proper deflection.
(5) Connect choke cable to carburetor.
(6) Connect hand throttle linkage and install accelerator pedal.
(7) Install hand brake cables; install hydraulic brake line at T fitting, making snug connection.

(8) Install lubrication lines and tighten fittings securely.
(9) Position cable guards and install over sheave yokes under mast.
(10) Connect clutch pedal linkage at each rod clevis.
(11) Install hinge pin levers on hinge brackets, using Allen wrench; tighten Allen screws securely.
(12) Install boom topping and load hoist operating lever linkage to levers; install winch brake operating rods to levers.
(13) Install gear shift levers in transmission case towers.
(14) Install boom and reeve cables as shown in figure 46.
(15) Test operation of engine, clutch, winch brakes, boom topping and load hoist winches, and foot brakes. Adjust if necessary.



1 Steering output shaft universal joint
2 Toeboard
3 Service brake return spring
4 Load hoist control lever
5 Sluing control lever
6 Instrument panel wire conduit and junctions
7 Steering gear case
8 Master cylinder push rod and boot
9 Boom topping control lever
10 Boom topping control lever mounting bracket
11 Engine clutch pedal arm
12 Engine clutch pedal return spring

Figure 43. Turntable assembly (mast support and top plate units).

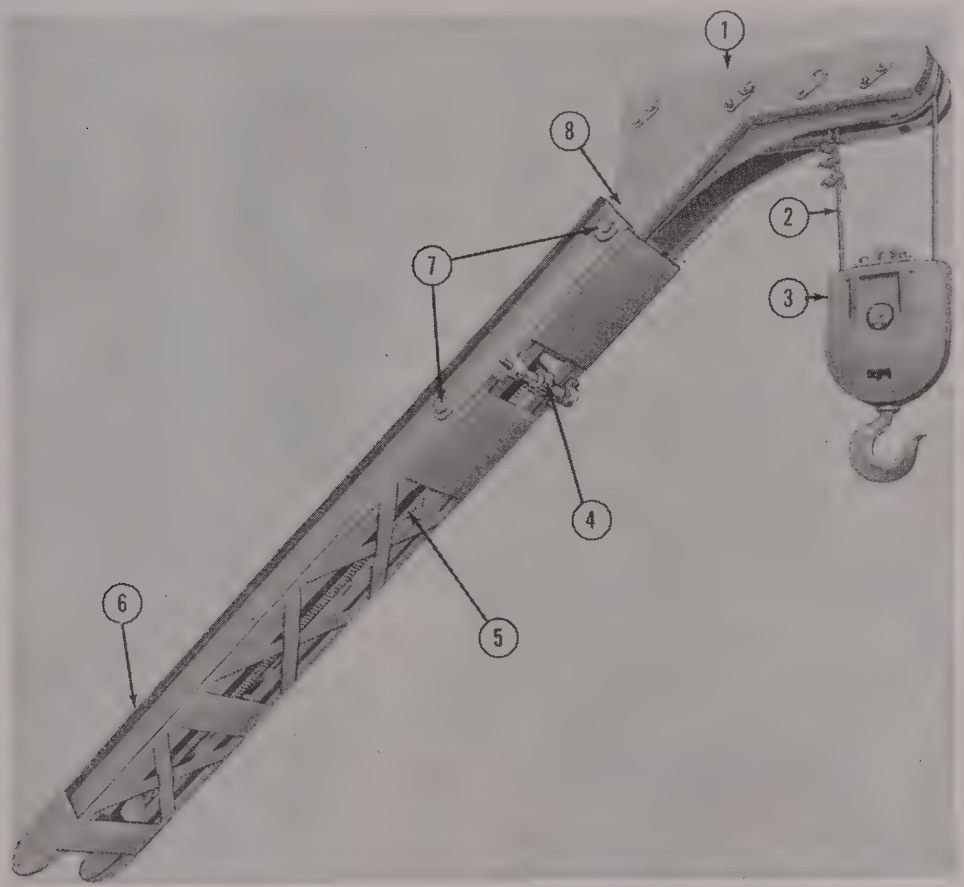
94. Boom

The telescoping boom, which is adjustable to various lengths between 12 and 18 feet, is of the gear- and rack-extension type. The boom (fig. 44) is extended or retracted by use of a hand crank. The boom head contains five sheaves, through which cables are reeved to operate the boom and load hoist.

a. Removal.

(1) Move boom to straight-ahead position.
(2) Lower load block to ground.
(3) Remove cable clamps that hold loop in cable around dead pin in boom.
(4) Remove load block from cable and pull cable through head of boom.
(5) Lower boom to floor or block for support.
(6) Remove clamps from boom topping cable dead end and remove cable, noting reeving of cable in sheaves.
(7) Remove cotter keys from inside ends of boom hinge pins.
(8) Remove cotter key from load line mast sheave pin and drive out sheave pin. Remove load line sheave.
(9) Drive out boom hinge pins and remove boom from hinge brackets, using suitable hoist. Block securely.

b. Installation. Reverse procedure in *a* above; reeve cables in accordance with instructions on reeving diagram. Test operation of boom; inspect sheave pins for secure installation and examine sheaves for freedom of movement.



1 Boom head
2 Load line cable
3 Load block
4 Boom extension pinion
5 Boom extension rack
6 Boom base section
7 Boom extension lock pins
8 Boom head section

Figure 44. Boom, boom head, and load block.

95. Sheaves

The load hoist and boom topping cables move on eight 8-inch sheaves and three 10-inch sheaves. Sheaves are mounted on steel pins, which are equipped with lubrication fittings. Two of the three 10-inch sheaves are mounted on a V-bracket at the bottom of the mast to guide the cable from the winch drums and the other is located in the load block.

96. Load Block

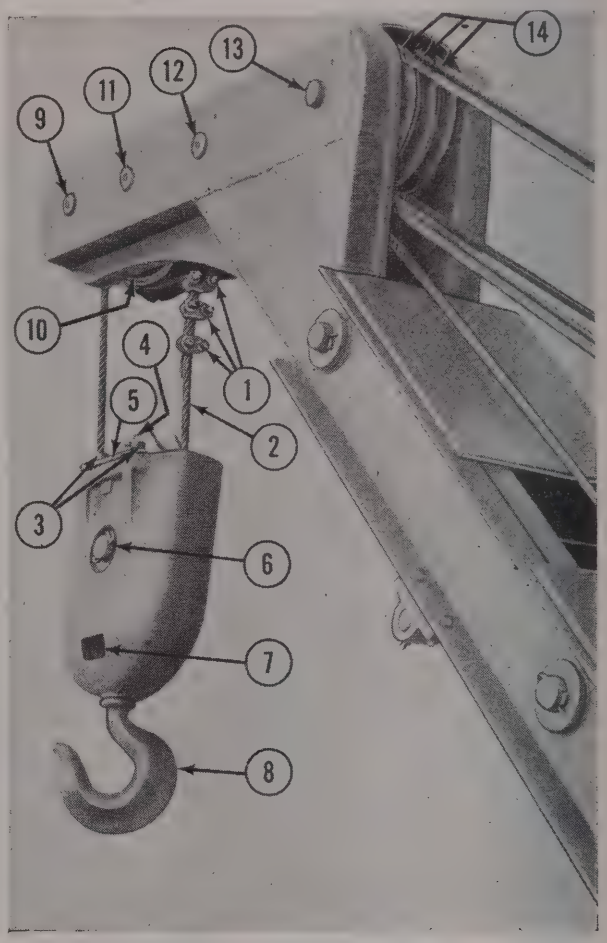
The load block (fig. 45) is a single casting with special angles mounted on its top. The steel pin which passes through these angles is used as a dead-end pin whenever the use of a 3-part load line is desirable. The load block sheave carries a cable which is connected to the dead-end pin at one end and moves through connecting sheaves to the load hoist winch at the other end. The load block hook rotates 360° in either direction.

a. Removal.

(1) Lower block to floor and remove cable.
(2) Remove cotter pin from either end of pin mounted on special angles and drive out pin.
(3) Remove four cap screws and washers securing angles to top of block and remove angles.
(4) Remove cotter key and drive out load block sheave pin; lift out sheave.
(5) Insert pliers through access hole at hook end of block and remove cotter pin from recess in castellated nut; hold nut in place and rotate hook until nut is free and may be removed through recess.
(6) Remove hook.

b. Installation.

(1) Place hook in position and install castellated nut; secure with cotter pin.
(2) Place load line cable around sheave and position sheave in block; install sheave pin and secure with cotter key.
(3) Position angles on top of block and install four cap screws and washers in angles; tighten cap screws securely.
(4) Install pin in angles and secure free end with cotter pin.
(5) Install load line cable on dead-end pin in boom head. Be sure that clamps are securely installed at cable dead end.



1 Load line cable clamps
2 Load line cable
3 Angle mounting cap screws
4 Dead-end pin for three-part line
5 Angles
6 Load block sheave pin
7 Castellated nut access hole
8 Hook
9 Load line sheave pin
10 Load line sheave
11 Load line cable dead-end pin
12 Load line guide sheave pin
13 Boom topping sheave pin
14 Boom topping sheaves

Figure 45. Boom head and load block.

97. Reeving

The crane may be reeved for single, double, or three-part load hoist line without additional parts. Single line is used only for light loads and fast hoist speeds. Double hoist line is used for average loads; three-part line is used when load is heavy and speed of hoist is slow. The boom topping line is a six-part line and method of reeving should not be changed. Refer to the reeving diagram (fig. 46) when installing or replacing cables.

a. Boom Topping Line.

(1) Pass cable over left sheave at top of mast, down inside of mast, under left hand sheave beneath top plate and back and under drum on boom topping (left hand) winch. Attach to drum by two ½-inch wire rope clips through holes provided in drum flange.

(2) Carry other end of cable forward from mast and over top of left sheave at rear of boom head, back and over center sheave in mast, forward and over center sheave at rear of boom head, back and over right sheave in mast, forward and over right sheave at rear of boom head, and back to pin on dead-end arm at top of mast. Use ¾-inch wire rope thimble and three ½-inch wire rope clamps to attach cable dead end to pin.

b. Single Load Hoist Line.

(1) Remove clamps and thimble from cable at dead-end pin in boom head.

(2) Install thimble on pin at top of lead block.

(3) Place dead end of cable around thimble and install cable clamps to secure.

c. Double Load Hoist Line.

(1) Pass cable over top of sheave at base of mast; around and under right sheave in bracket at base of front end top plate.

(2) Lead cable back to underside of load hoist winch drum (right side) and attach to drum with two ½-inch wire rope clamps through holes in drum. Tighten nuts on clamps securely.

(3) Lead other end of cable over top of center sheave and front end sheave in boom head. Lead cable down and around load block sheave and up to dead-end pin in boom head. Secure cable to dead-end pin with ¾-inch thimble and three ½-inch cable clamps.

d. Three-Part Load Hoist Line.

(1) Perform *c* (2) and (3) above.

(2) Lead cable over center sheave in boom head and down and around sheave in load block.

(3) Lead cable up and over sheave at outer end of boom head and down to load block.

(4) Install dead end of cable on pin at top of load block. Use ¾-inch thimble and three ½-inch cable clamps to make installation.

98. Reeving Precautions

Always use a cable of the proper length. When cable has been unwound to maximum length, be sure that at least three turns of cable remain on the winch drum to prevent excessive strain on drum cable clamps. Keep cables in line on winch drums and do not subject to jerky operation of winches. Keep cables clean and do not operate a cable that has become kinked. Reverse cables at intervals to avoid uneven wear. Following the installation of a cable, always operate under a light load to permit cable to become properly seated.

99. Boom Topping Cable

The boom topping cable is a ½-inch, 6 x 19 preformed plow steel cable, 120 feet long. Strands are wound on a hemp center.

a. Removal.

(1) Lower the boom to a support placed beneath the boom head in such a position that the boom will be horizontal when lowered. Set the hand brakes to prevent the crane from moving.

(2) Remove clamps and thimble from cable at mast dead-end arm pin. Pull the cable through the sheaves on the boom head and mast.

(3) Have an assistant slowly operate boom topping winch with shifting lever in DOWN position. Pull cable through sheave at top of mast fast enough to prevent kinking as it is let out by the winch. Form cable into coil. Remove clamp at winch drum and remove cable.

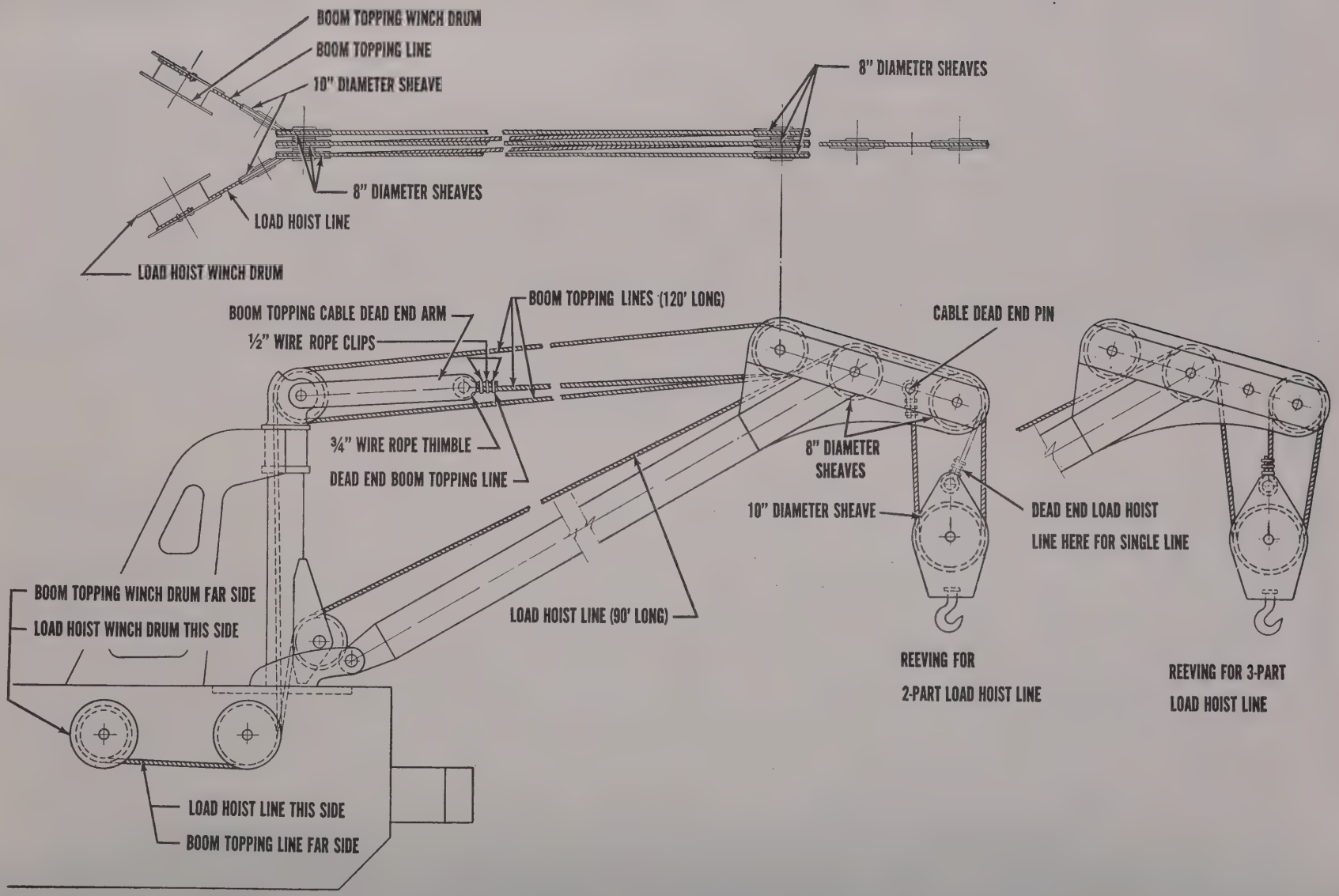

BOOM TOPPING WINCH DRUM
BOOM TOPPING LINE
10" DIAMETER SHEAVE
8" DIAMETER SHEAVES
8" DIAMETER SHEAVES
LOAD HOIST LINE
LOAD HOIST WINCH DRUM
BOOM TOPPING CABLE DEAD END ARM
½" WIRE ROPE CLIPS
BOOM TOPPING LINES (120' LONG)
¾" WIRE ROPE THIMBLE
DEAD END BOOM TOPPING LINE
CABLE DEAD END PIN
8" DIAMETER SHEAVES
10" DIAMETER SHEAVE
DEAD END LOAD HOIST LINE HERE FOR SINGLE LINE
BOOM TOPPING WINCH DRUM FAR SIDE
LOAD HOIST WINCH DRUM THIS SIDE
LOAD HOIST LINE (90' LONG)
REEVING FOR 2-PART LOAD HOIST LINE
REEVING FOR 3-PART LOAD HOIST LINE
LOAD HOIST LINE THIS SIDE
BOOM TOPPING LINE FAR SIDE

Figure 46. Cable reeving diagram.

b. Installation.

(1) Install in accordance with directions for reeving listed in paragraph 97.

(2) After the cable has been wound on winch drum, operate the boom up and down several times to remove kinks and seat cable properly.

100. Load Hoist Cable

The load hoist cable is a ½-inch, 6 x 37 preformed plow steel cable, 90 feet long.

a. Removal.

(1) Lower the boom to a horizontal position and support solidly.

(2) Remove clamps and thimble from dead-end pin on load block or in boom head, depending upon which method of reeving has been used.

(3) Have an assistant slowly operate load hoist winch in DOWN position. Pull cable through sheave in end of boom and form into coil.

(4) Stop load hoist winch as the last turn of cable on winch drum is reached; remove cable clamp and pull remainder of cable through sheave at end of boom head.

b. Installation.

(1) Reeve cable as outlined in paragraph 97.

(2) Wind enough cable on the winch drum to cover the drum surface. Stretch remainder of cable out to full length in front of boom.

(3) Operate winch with control in UP position and wind cable slowly and evenly on drum. Have assistant keep cable in tension as it is drawn through sheaves to prevent cable kinking or jumping sheaves.

(4) Install end of cable on load block dead end pin or boom head dead-end pin, as desired, and secure with cable clamps. Operate the load line up and down several times, under light load, to stretch and seat cable evenly and work out twists which may be present.

101. Cable Maintenance

Lubricate cables in accordance with instructions on Lubrication Order 10–1692A–1. Inspect for broken or frayed strands and loose clamps before operation and at least once each day. Be constantly alert for kinks in cables. Clean cables at frequent intervals with dry cleaning solvent and a wire brush. When storing cable, use a cable reel when possible. If reel is not available, tie a 3-foot loop in the end of the cable and roll loop along, coiling the cable. Wire coiled cables to prevent uncoiling and be sure that they are properly lubricated to avoid deterioration. Always store cables in a dry, well ventilated place.

CHAPTER 5

DEPOT MAINTENANCE

Section I. ENGINE

102. Over-All Unit

a. Disassembly. Refer to figure 47 and proceed as follows:

(1) Remove cylinder head (par. 42*a*) and oil pan (par. 45*a*).
(2) Remove intake and exhaust manifolds (par. 41*a*).
(3) Remove timing gears (par. 105*a*).
(4) Remove valves (par. 47*a*).
(5) Remove flywheel (par. 104*a*).
(6) Remove pistons and connecting rods (par. 108*a*).
(7) Remove camshaft (par. 107*a*).
(8) Remove crankshaft (par. 109*a*).

b. Reassembly.

(1) Install crankshaft (par. 109*e*).
(2) Install camshaft (par. 107*c*).
(3) Install valves (par. 47*b*).
(4) Install pistons and connecting rods (par. 108*j*).
(5) Install timing gears (par. 105*d*).
(6) Install intake and exhaust manifolds (par. 41*b*).
(7) Install oil pan (par. 45*c*) and cylinder head (par. 42*b*).

103. Intake and Exhaust Manifolds

a. Disassembly. Refer to figure 48 and proceed as follows:

(1) Loosen and remove nuts (20) and washers (21) from exhaust to intake manifold studs (23) and separate manifolds.
(2) Remove intake manifold vacuum outlet plug (14). Remove throttle trunnion (13) to complete disassembly of intake manifold.
(3) Loosen counterweight screw (3) and remove counterweight lock (1).
(4) Remove exhaust thermostat control valve spring (4) from screw; remove counterweight (2).
(5) Remove control valve coil spring (6) and remove coil spring pin (8).
(6) Remove thermostat control valve shaft (5) and remove control valve (9).
(7) Drive out valve shaft bushing (7) with a soft drift to complete disassembly of exhaust manifold.

b. Reassembly. To reassemble the intake and exhaust manifolds, reverse the procedure in *a* above and tighten all connections.

104. Flywheel

a. Removal.

(1) If clutch housing and clutch have been removed, remove four retaining bolts and lock ring.
(2) Install flywheel puller and remove flywheel from crankshaft flange.

b. Installation.

(1) Install rear engine plate.
(2) Turn crankshaft until No. 1 piston is at top and both valves are closed.
(3) Make sure mating surfaces of flywheel and crankshaft flange are clean. Install flywheel.
(4) Install retaining bolts and tighten to 70 to 80 pound-feet torque.

c. Inspection.

(1) Examine starting gear for cracks, damaged teeth, and for looseness on flywheel. Cracks in gear may be detected by sounding with a hammer.
(2) Check dowel and bolt holes in flywheel for elongation. Replace if elongated.
(3) Check clutch face of flywheel for excessive wear.
(4) Check clutch pilot bushing for wear.

d. Starting Gear Replacement.

(1) Remove flywheel ring gear by drilling a ¼-inch hole through gear from engine side of gear. Be careful not to drill into flywheel, as this will affect the balance of the flywheel assembly.

(2) Split gear in half and remove from flywheel, using a chisel and hammer.

(3) Make sure mating surfaces of gear and flywheel are clean and not damaged before installing a new flywheel ring gear.

(4) Expand gear by heating to approximately 360° F., then position over flywheel. This operation must be performed quickly as the gear will cool rapidly and contract. Replacing flywheel gear in any other manner may result in gear working loose from flywheel.

(5) Check gear runout. Runout must not exceed .010 inch.

105. Timing Gear Assembly

The timing gear assembly consists of two gears: the crankshaft gear, keyed to the crankshaft; and camshaft gear, attached to the camshaft. When these gears are meshed so that timing marks are alined, proper timing of the lifting of valves by the camshaft is assured.

a. Removal. The following procedure may be used when engine repair does not involve removal of the crankshaft or camshaft.

(1) Remove main power take-off pulley.

(2) Remove cap screws and washers and remove timing gear cover.

(3) Install gear puller in cores in camshaft timing gear and remove gear. Use extreme care when removing gear, as tooth contact interference may occur. If this occurs, revolve crankshaft slightly to free teeth. Forcing gear may cause burr and resultant noisy operation.

(4) Remove oil pan and turn crankshaft to aline timing marks.

(5) Remove front main bearing cap.

(6) Remove crankshaft timing gear (fig. 49), using gear puller. Be careful not to burr gear.

b. Cleaning. Place timing gears in dry cleaning solvent and remove imbedded sludge with stiff wire brush.

c. Inspection. Check condition of bore, keyway, and teeth of each gear. Replace gears if excessively worn or if teeth are badly chipped or broken.

d. Installation.

(1) Position crankshaft timing gear on crankshaft so that keyway alines with key and timing marks are away from engine block.

(2) Install crankshaft timing gear installing tool in crankshaft, making sure puller stud is fully threaded into crankshaft.

(3) Assemble spacer and nut on end of installing tool and tighten nut to pull timing gear into place.

(4) Position camshaft timing gear on camshaft with keyway alined with key in camshaft. Make sure that timing mark is in line with O on crankshaft gear.

(5) Press on timing gear with suitable tool, leaving a .003- to .006-inch clearance between the gear and thrust plate.

(6) Check timing marks for proper alinement and adjust gear backlash to .002 to .003 inch, using feeler gage to determine backlash between timing gear teeth.

(7) Install front main bearing cap.

(8) Install oil pan and tighten mounting cap screws securely.

(9) Install main power take-off pulley.

106. Valve Assemblies

a. Valve guides.

(1) *Removal.* After valves have been removed (par. 47*a*), remove the valve guides with a valve guide puller. An exploded view of the valve assembly appears as figure 50.

(2) *Installation.* Measure diameter of bore and outside diameter of new valve guide. Compare measurements. Valve guide should be a .0006- to .0024-inch press fit. Install valve guide in bore, using an appropriate installing tool. Measure valve guide height with depth gage. Exhaust valve guide should be 1.08 inches from top of cylinder block; intake valve guide 1.18 inches from top of cylinder block.

b. Valve Seats. Always inspect valve seats when valves and valve guides have been removed. If seats are marked or scratched, they should be reconditioned with an eccentric-type grinder. In reconditioning valve seats, do not take heavy cuts. After grinding has been completed, check valve

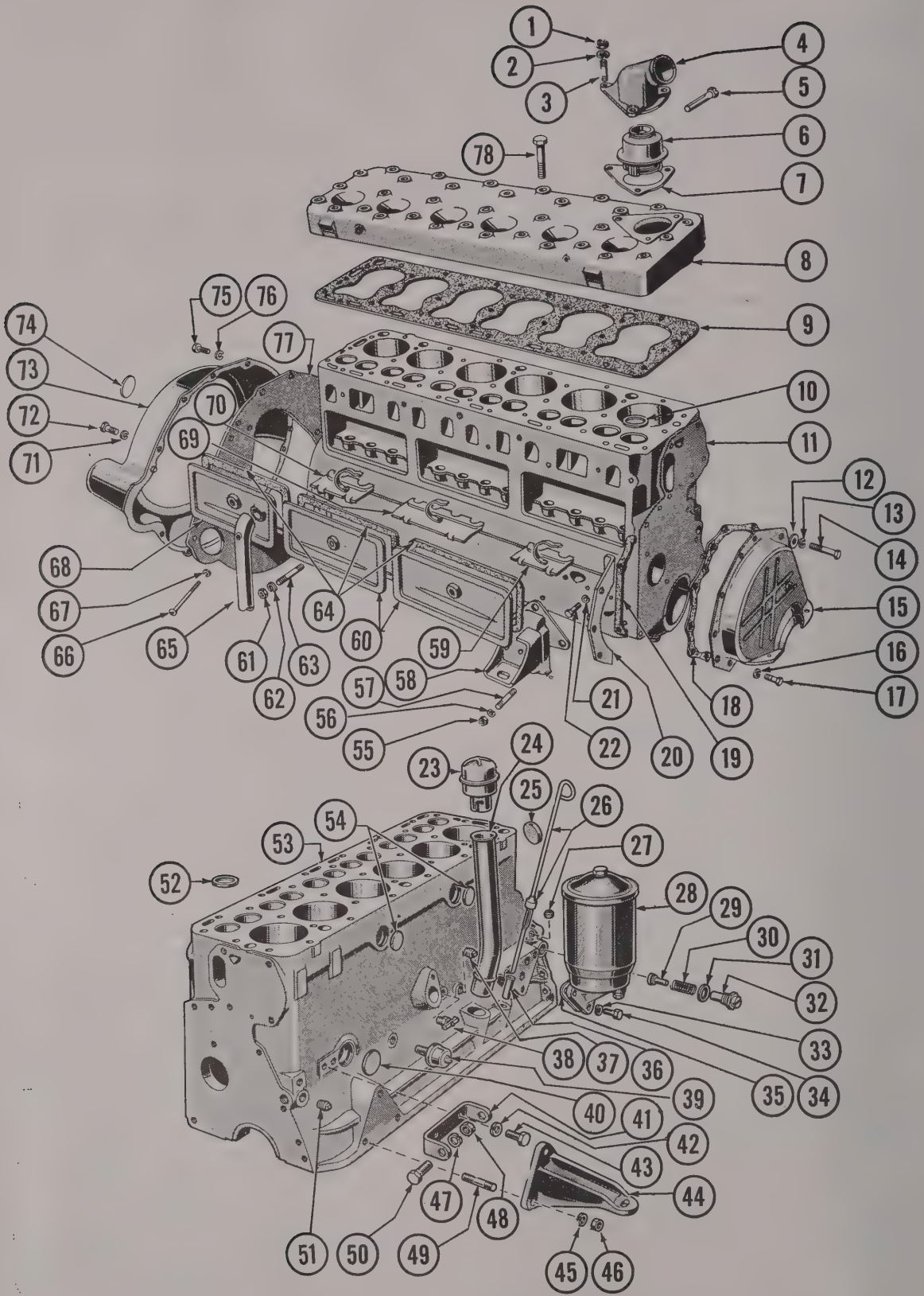
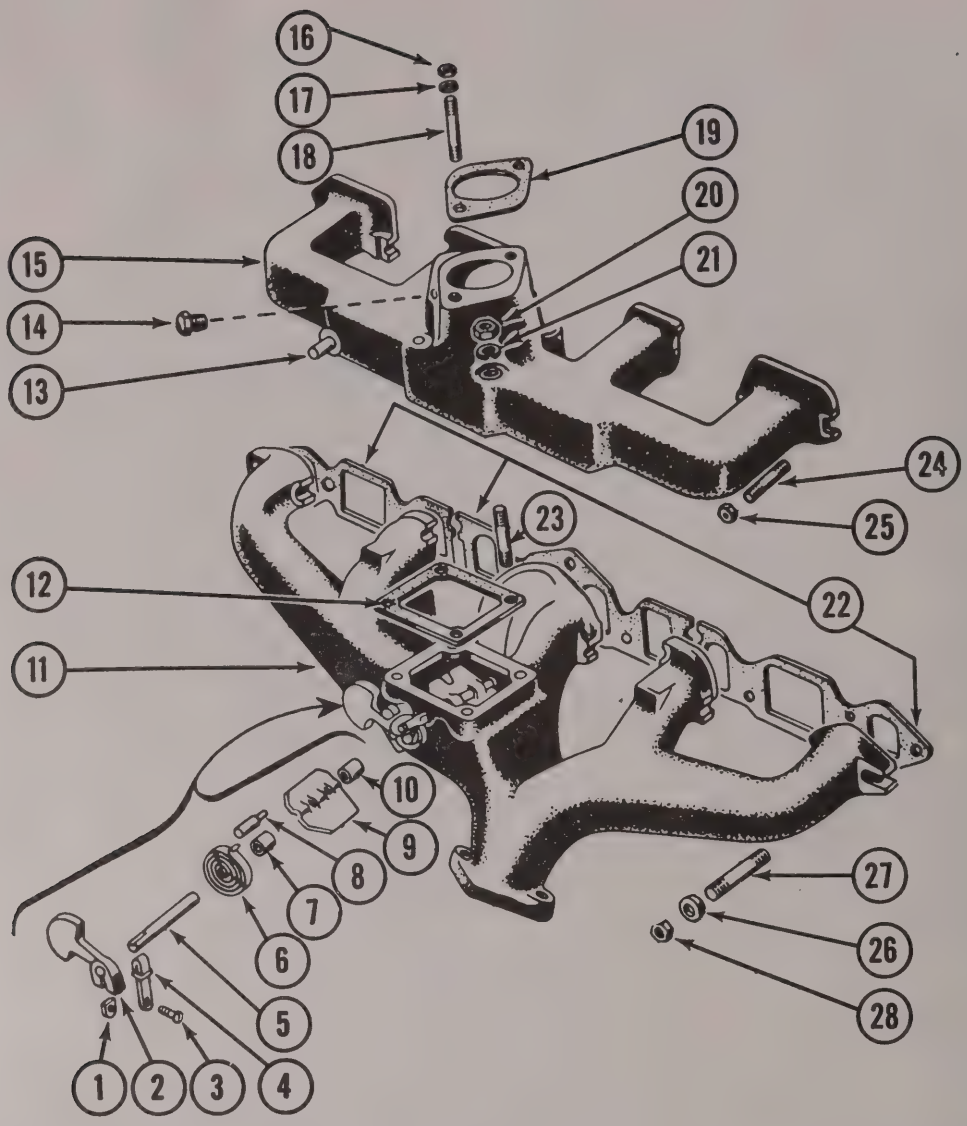


Figure 47. Engine—exploded view.

1 Stud nut
2 Lock washer
3 Water outlet mounting stud
4 Cylinder head water outlet
5 Temperature indicator bulb
6 Thermostat
7 Gasket
8 Cylinder head
9 Gasket
10 Valve seat
11 Cylinder block
12 Flat washer
13 Lock washer
14 Cap screw
15 Timing gear front cover
16 Lock washer
17 Front cover attaching cap screw
18 Gasket
19 Gasket
20 Timing gear side cover
21 Lock washer
22 Side cover cap screw
23 Oil filler cap
24 Oil filler pipe
25 Expansion plug
26 Oil level indicator
27 Oil outlet plug
28 Oil filter
29 Oil relief valve plunger
30 Plunger spring
31 Plug gasket
32 Plug
33 Lock washer
34 Oil filter mounting cap screw
35 Gasket
36 Oil level indicator tube
37 Oil outlet plug
38 Drain plug
39 Oil pressure gage engine unit
40 Expansion plug
41 Generator bracket
42 Lock washer
43 Generator bracket mounting cap screw
44 Engine front support bracket
45 Nut
46 Lock washer
47 Nut
48 Lock washer
49 Support bracket mounting stud
50 Generator mounting bolt
51 Oil outlet plug
52 Valve seat
53 Cylinder block
54 Expansion plugs
55 Stud nut
56 Lock washer
57 Support bracket mounting stud
58 Engine support bracket
59 Valve chamber oil baffle
60 Valve chamber covers
61 Nut
62 Lock washer
63 Valve chamber cover mounting stud
64 Valve cover gaskets
65 Ventilation extension tube
66 Extension tube mounting cap screw
67 Lock washer
68 Valve chamber cover
69 Valve chamber center oil baffle
70 Valve chamber oil baffle
71 Lock washer
72 Flywheel housing mounting cap screw
73 Flywheel housing
74 Expansion plug
75 Flywheel housing mounting cap screw
76 Lock washer
77 Engine rear plate
78 Cylinder head bolt

Figure 47—Continued



1	Lock	11	Exhaust manifold	21	Lock washer
2	Counterweight	12	Gasket	22	Gasket
3	Screw	13	Throttle trunnion	23	Stud
4	Spring	14	Plug	24	Stud
5	Shaft	15	Intake manifold	25	Nut
6	Coil spring	16	Nut	26	Clamp
7	Bushing	17	Washer	27	Stud
8	Pin	18	Stud	28	Nut
9	Valve	19	Gasket		
10	Bushing	20	Nut		

Figure 48. Intake and exhaust manifolds—exploded view.

seat for runout with a runout indicator, if available. If an indicator is not available, runout may be checked with a pencil as follows:

(1) Mark across face of refaced valve with pencil.

(2) Insert valve in correct port and position lapping tool over valve head.

(3) Exert light pressure on tool and rotate valve one-half turn to right and one-half turn to left. Remove valve and examine pencil marks.

(4) If pencil marks are smeared evenly over width of valve seat and around valve face, the valve seat and face are parallel and correct reconditioning has been accomplished.

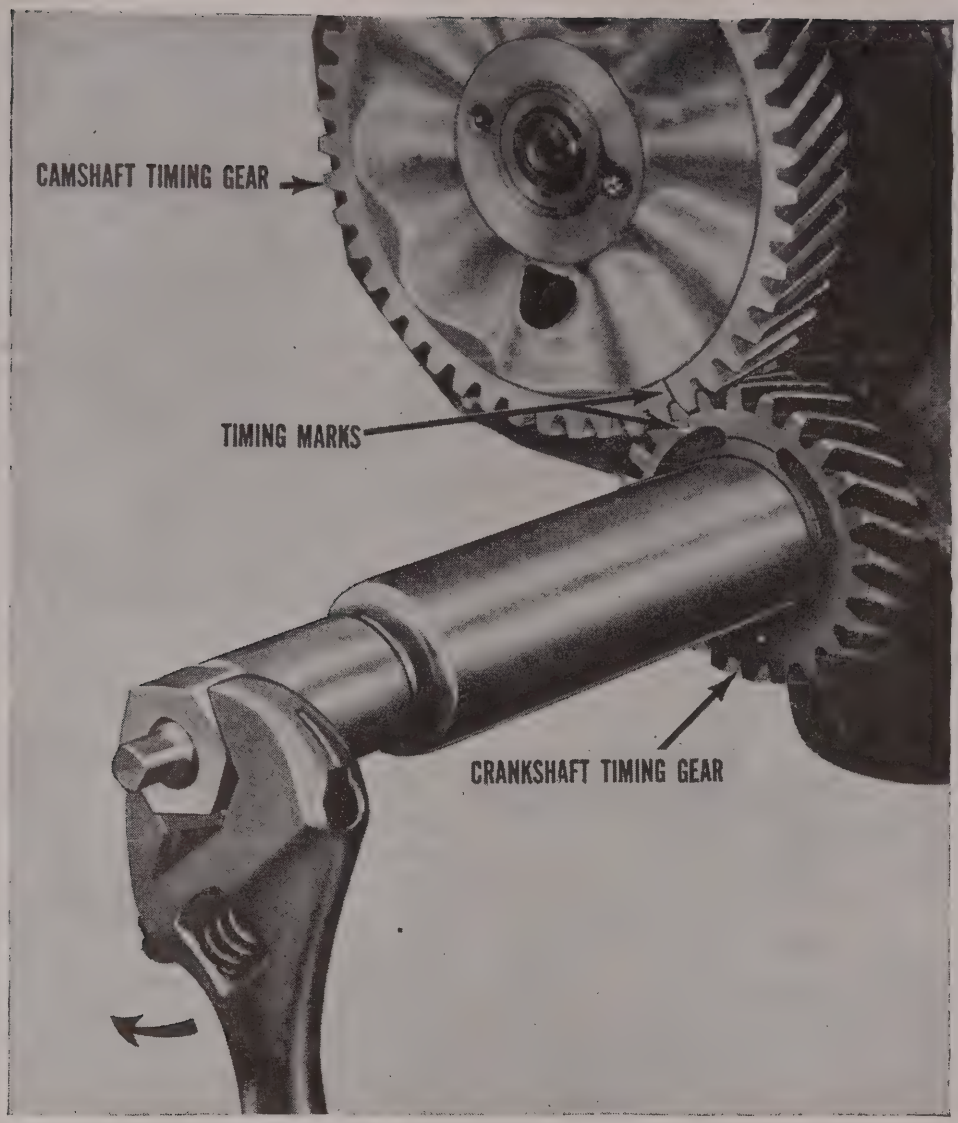


Figure 49. Removing crankshaft timing gear.

(5) If pencil marks are broken at the bottom or top of the valve face, further reconditioning of the valve seat will be required.

(6) Check width of valve seat face. It should be .065 to .080 inch. If width exceeds these specifications, further reconditioning will be required.

(7) If valve is properly seated, lap each valve and seat, using a fine grinding compound.

c. Valve Inspection and Service. The procedure listed below should be followed whenever valves and valve guides have been removed and before valves and valve guides are installed or valve seats reconditioned:

(1) Examine valves, valve seats, and guides for evidence of fractures. Replace valves if faces are deeply pitted or grooved or stems are warped more than .001 inch.

(2) Examine valve seats for cracks and evidence of valve hammering on seat. Valve seat angle should be 44° 30′ to 45° and valve seat face width should be .065 to .080 inch.

(3) Replace exhaust valve seat inserts that are lose or badly pitted.

(4) Replace valves with more than .002 inch wear and more than .0015 inch out-of-round. Examine valve springs for fractures, cracks, or poor condition. Check

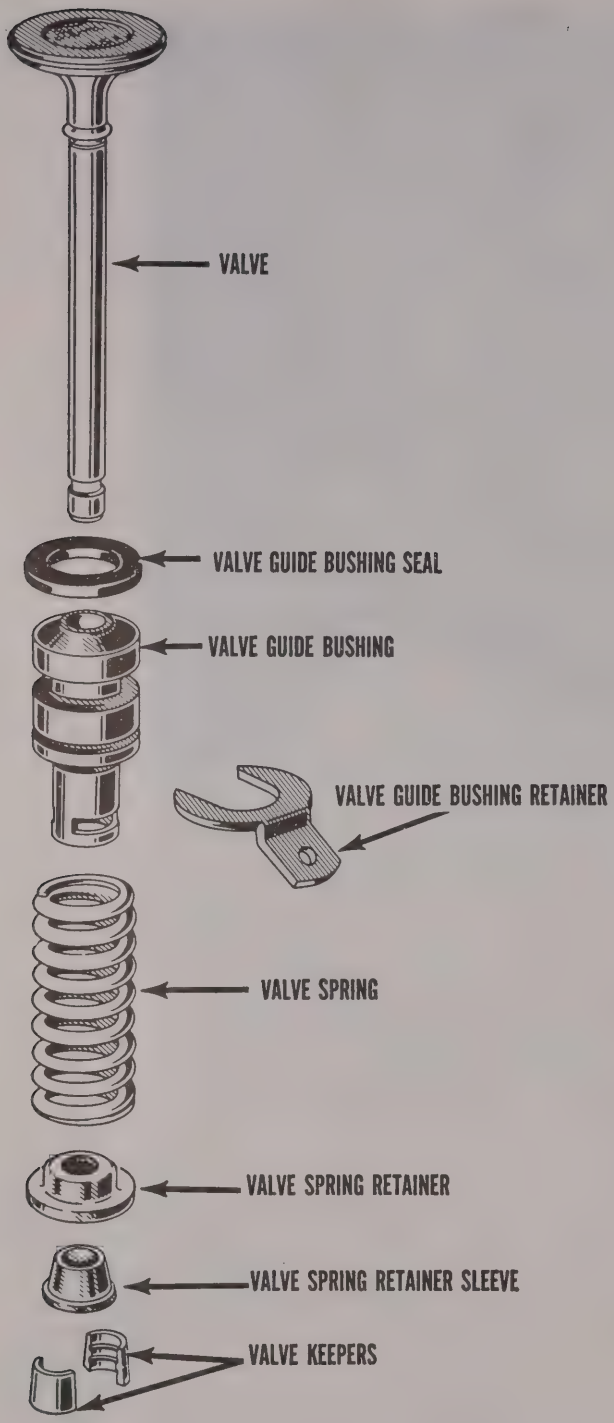


Figure 50. Valve assembly—exploded view.

valve springs with valve spring compressed to a length of 2.109 inches; indicator should register a tension of 47 to 53 pounds.

(5) If necessary, reface valves, using a wet valve refacer to grind valve faces. Valve face angle should be 90° to 90°30′ for both intake and exhaust valves.

d. Valve Clearance. Turn engine crankshaft until exhaust valve is in full open position. If an indicator is available, position it on the valve head. Set the indicator at zero and move the valve downward with fingers while observing indicator reading. The reading should indicate a clearance of .0002 to .0004 inch between valve cap seat and end of valve stem. If an indicator is not available, rotate the valve when in full open position. It must be free to rotate without noticeable vertical movement.

e. Valve Tappets. In order to remove valve tappets, it is necessary to remove the camshaft (par. 107*a*), and then to remove the push rod and tappet adjusting screw from cylinder block. Inspect tappet and tappet adjusting screw for signs of excessive wear. Replace push rod if diameter is less than .6230 inch and clearance between rod and bore is more than .004 inch.

107. Camshaft

a. Removal. The camshaft can be most easily removed by placing the engine on an engine stand and then removing the distributor, valves, and oil pump. It is then necessary to invert the engine to prevent valve tappet interference. Next, remove the timing gear cover and the camshaft timing gear, as described in paragraph 105*a*. Next, remove the two cap screws that hold the camshaft thrust plate to the block and pull the camshaft from the engine. An exploded view of the camshaft appears as figure 51.

b. Inspection.

(1) Replace camshaft if journals are excessively scored, nicked, or discolored from heat.

(2) Measure diameter of journals with a micrometer for wear and out-of-round. Replace camshaft if journals measure less than 1.924 inches in diameter.

(3) Measure inside diameter of camshaft bearing. Compare with measurement of journal diameter to determine clearance. Clearance must not be over .005 inch for a used camshaft and bearings and must be between .001 inch and .002 inch for new camshaft and bearings. If replacement of bearings is necessary, refer to paragraph 107*d* for procedure.

(4) Replace camshaft if oil pump drive gear

is excessively worn or if teeth are missing.

(5) Replace camshaft timing gear if excessively worn or if teeth are missing.

c. Installation.

(1) Assemble thrust plate over camshaft forward end with spot-faced side away from camshaft bearing.

(2) Install key in keyway.

(3) Install hub, using an arbor press.

(4) Check end thrust clearance between thrust plate and hub. Clearance should be .003 to .006 inch.

(5) Position camshaft in block. Install and tighten thrust plate retaining screws.

(6) Install camshaft timing gear (par. 105*d*).

(7) Check gear lash. It should be between .001 and .002 inch.

(8) Install locking ring and retaining cap screws. Tighten cap screws to 15 to 20 pound-feet torque.

d. Camshaft Bearing Replacement.

(1) Remove welsh plug at end of block.

(2) Remove camshaft bearings with appropriate tool.

(3) Install new camshaft bearings. Make certain oil hole in bearing and bore are in alinement. Bearings are of the precision type. Do not ream.

(4) Check hole alinement after bearing is installed by removing screw plugs in lock at main oil galley and looking through the holes while holding a light on the bearings.

108. Connecting Rod and Piston Assemblies

a. Removal.

(1) Remove oil pan and cylinder head.

(2) Turn engine crankshaft until piston is at bottom of its stroke.

(3) Check cylinder at top of ring travel for ridge. If ridge is present, it must be removed with a ridge remover or file.

(4) Turn crankshaft until rod of piston to be removed is down.

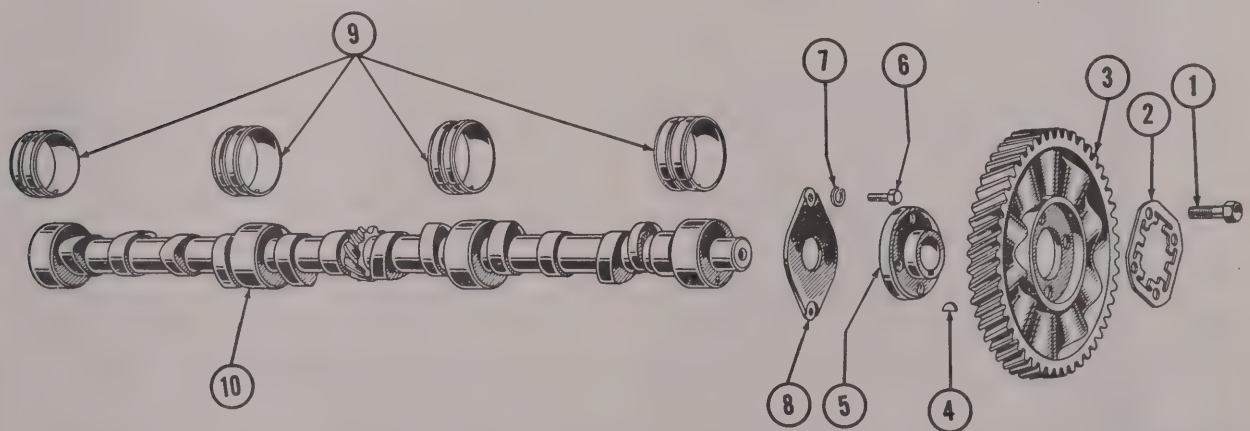
(5) Remove nuts from connecting rod studs.

(6) Lift connecting rod bearing cap from rod.

(7) Remove connecting rod and piston assembly out of top of cylinder by pushing with handle end of hammer.

(8) Install rod bearing cap on connecting rod. Each rod and bearing cap is numbered from 1 to 6 beginning at timing gear end of engine. Numbers on rod and bearing cap must be on same (camshaft) side when reinstalling into their respective cylinder bores. If a connecting rod is transposed from one block to another, make sure all bearings are new and that number on rod is restamped or prick-punched to correspond with cylinder number.

(9) File cylinder number on inside bottom of piston skirt prior to removing rods from pistons for identification of piston with bore for reassembling purposes.



1 Camshaft gear bolt
2 Camshaft gear ring
3 Camshaft gear
4 Key
5 Hub
6 Thrust plate bolt
7 Lock washer
8 Thrust plate
9 Bearing
10 Camshaft

Figure 51.—Camshaft—exploded view.

b. Disassembly. Refer to figure 52 and proceed as follows:

(1) Remove piston rings, using piston ring expander.

(2) Clamp connecting rod in a vise having soft metal jaws, then grasp piston with hands and pull to check for piston pin bushing wear. Any vertical movement with reference to piston travel that can be felt indicates that reconditioning is necessary.

(3) Remove lock rings at each end of piston pin. Use snap ring pliers or reach under piston pin lock rings with an awl at slot in pin boss.

(4) Push piston pin out of piston or, if necessary, hold piston in vise and remove by tapping with a light hammer on a brass drift slightly smaller than pin diameter.

c. Cleaning.

(1) Remove carbon from piston head with scraper or mechanical carbon brush.

(2) Clean piston ring grooves with a ring groove cleaner.

(3) Clean carbon from oil return holes in oil ring grooves by running a drill through holes. Be sure drill is same size as hole.

(4) Clean all parts and passages in dry cleaning solvent.

(5) Remove bearing inserts (tie together in pairs and identify if inserts are to be reused) and thoroughly clean rod bore and back of insert. Make certain oil squirt holes are clean.

d. Inspection.

(1) Replace connecting rods with damaged threads, nicked studs, deep nicks, signs of fractures, scored bore, or bore out-of-round more than .002 inch.

(2) Check piston pin bushing in connecting rod for wear, using a new piston pin. Pin should be a .0005-inch press to .0001-inch slip fit in rod bushing. If new piston pin falls through bore by its own weight, ream for next oversize pin or replace bushing.

(3) Replace connecting rod that shows visible signs of twist or bend. Check every connecting rod for alinement of fixture (fig. 53) after fitting piston pins.

(4) Exercise care in bending rods to overcome misalinement as fractures may be caused by excessive bending of rod. This operation should not be attempted unless proper equipment is available.

(5) Replace bearings that are scored (burned), and have overlay wiped out across face, particularly one-third of the way from parting line of bearing.

(6) Replace bearings that show fatigue failure. Fatigue failure can be recognized by breaking away of bearing overlay material. When fatigue failure is limited to only a small section of bearing surface, it indicates high spots in bearing caused by dirt or other foreign material between bearing and bearing bore.

(7) A bearing with light scratches on inside diameter can be re-used providing clearances are satisfactory; however, engine oil system should be carefully cleaned as scratched bearings are caused by dirt in oil.

(8) Bearings that show signs of excessive wear on one side of bearing half indicate a tapered bearing journal. Bearing journal should be reground to next undersize (table V) to remove taper and undersize bearings should be installed. Similarly, bearings showing excessive wear at center or ends of bearing about circumference indicate high spots on bearing journal which should be corrected before engine is rebuilt.

(9) Bearings showing bright sections across back of bearing indicate bearings have been loose in bore either because of an undersize outside diameter, because of bearing bore being too large, or by bearing not having sufficient crush. In either case, cause should be corrected.

(10) Install bearing inserts in cap and rod section. Bearing should snap in place and remain there. If bearing slides freely in and will fall out readily, bearing has lost its spread and should be replaced.

(11) Check inside edge of bearing at parting line for sharp burrs. Remove burrs if any are apparent.

(12) Check parting edges of bearings for dirt or other foreign particles.

(13) Hold bearing insert firmly in bearing cap. Place a straightedge over open end of bearing. Straightedge should be held .001 to .003 inch from parting line of cap by bearing crush. If straightedge rests on bearing cap parting line edges, replace bearing. Bearing crush tends to hold bearing firmly in bearing bore to give support to bearing and also assures better dissipation of heat from bearing to rod.

(14) Inspect pistons for fractures at ring lands, skirt and pin bosses. Replace pistons that show signs of wavy ring lands, fractures, or damage from detonation. Spongy eroded areas near edge of piston top, usually on side opposite valves, are caused by detonation. In some instances holes are also burned through piston top.

(15) Clamp rod in vise and move piston, first toward then away from rod, with hands. If movement can be felt, oversize piston pins may be necessary. This test depends on piston pin being correct fit in rod bushing. Piston pin should be a .0005-inch press to .0001-inch slip fit in piston at normal room temperature. Piston pins should be a hand press fit in rod bushing when piston and pin are at 70° F. If piston pins fit loosely (slide through by own weight) pistons must be replaced or piston pin bores reamed to accommodate next oversize piston pin.

(16) Check piston fit in cylinder bores to make sure pistons can be re-used before attempting to fit piston pin bores with oversize piston pins.

(17) Replace pistons that show excessive skirt wear.

(18) Insert a new piston ring in ring groove. With a feeler gage, check clearance between top of ring and groove (fig. 54). If clearance exceeds .004 inch for oil ring or compression rings, replace pistons.

(19) Replace pistons that are bellmouthed at their outer circumference of land so that a gage of .006-inch thickness can be inserted between a new ring and ring land a distance of one-sixteenth of an inch in from face of piston.

(20) Replace piston pins that show signs of fractures or etching.

(21) Replace piston pins that show wear or are a loose fit in piston or in rod bushing.

(22) Replace all piston pin retainers.

e. Measuring Cylinder Bores. Measure the cylinder bore as follows for taper, out-of-round and wear, using inside micrometers.

(1) Measure diameter of cylinder lengthwise of block at top of cylinder where greatest ring wear occurs.

(2) Measure diameter of cylinder lengthwise of block at bottom of piston skirt travel.

(3) Measure diameter taken crosswise of block at top of cylinder at point where deepest ring wear occurs.

(4) Measure diameter taken at bottom of piston skirt travel crosswise of cylinder block.

(5) To determine cylinder taper, compare measurement obtained in (1) above with measurement in (2) above; and measurement obtained in (3) above with measurement in (4) above. If taper is in excess of .006 inch, cylinder will require reboring and honing for oversize piston.

(6) To determine cylinder out-of-round, compare measurement obtained in (1) above with measurement in (3) above; and measurement obtained in (2) above with measurement in (4) above. If out-of-round exceeds .006 inch, cylinders will require reboring and honing for oversize piston.

f. Fitting Pistons.

(1) Thoroughly clean cylinder bores and pistons.

(2) Attach tension scale to end of feeler ribbon.

(3) Position feeler ribbon thrust side of piston (camshaft side) 90° from piston pin hole.

(4) Invert piston, then push in cylinder so end of piston is about one-half inch below top of block. Make sure piston pin bores are parallel with camshaft.

(5) Pull out feeler gage while noting reading. Reading on scale should be between 5 and 10 pounds. If scale measures more than 10 pounds, try another piston or hone cylinder bore to obtain fit. If scale registers less than 5 pounds, try another piston; if none can be fitted, bore cylinders to next oversize (fig. 55).

(6) Assemble pistons to connecting rod numbered for bore in which it is to be installed.

g. Fitting Piston Pins.

(1) Check piston pin fit in piston, using new piston pin.

(2) Piston pins must be a hand-push fit in piston bore at normal room temperature (70° F.) (fig. 56). Fit tolerances are .001-inch press fit to .0005-inch slip fit in rod bushing and .005-inch press to .0001-inch slip fit in piston boss. Unless oversize piston pins are being installed, it should not be necessary to enlarge piston pin bores in piston as pistons and pins are usually serviced in sets.

(3) If oversize piston pins are to be used, or if piston pins are fit too tightly, use an expansion type piston pin reamer having a pilot to ream piston pin bores to size.

(4) If hone is used instead of reamer, greater care must be exercised to prevent making piston pin bores bellmouthed. Parts must be thoroughly washed to remove abrasive particles.

(5) Check alinement of bore in bushing and connecting rod bearing bore on an alinement fixture. If the rod bearing and pin are not in perfect alinement, the connecting rod should be replaced.

(6) Assemble pistons and rods and lock piston pins in place with new retainers.

(7) Check alinement of piston and connecting rod assembly.

h. Fitting Piston Rings.

(1) Install piston ring in bore of cylinder. Invert piston and use top to push ring down about halfway into bore to true ring with cylinder bore.

(2) Measure ring gap with a feeler gage. If gap is less than .010 inch to .017 inch, remove ring and file ends until proper clearance is obtained (fig. 57).

(3) If gap exceeds .025 inch, next oversize ring must be used.

(4) After rings have been fitted in cylinder bore, they should be immediately installed on piston or identified with piston and cylinder bore in which they are to be installed.

(5) Check vertical clearance of all rings. Wear limit clearance for compression and oil rings is .005 inch. Original fit tolerances are contained in table V.

(6) Remove piston rings that are a tight fit in grooves and remove stock to obtain necessary clearance. Place a piece of emery cloth on surface plate or plate glass, then rotate ring over emery cloth. Polish ring in same manner, using crocus cloth. Always remove stock from top side of compression ring and bottom side of oil ring.

i. Installing Piston Rings. Install piston rings with piston ring applier as shown in figure 58.

j. Installing Pistons and Rods.

(1) Oil cylinder wall and floor piston with light grade motor oil.

(2) Make sure ring gaps are equally spaced about circumference of piston, then compress rings with ring compressor. Tap compressor lightly around circumference over rings as compressor is closed on rings to allow rings to close evenly.

(3) Remove connecting rod bearing cap.

(4) Check number stamped on connecting rod, then install piston in corresponding number cylinder bore with oil squirt hole in connecting rod facing camshaft (fig. 59). Crankshaft throw for this cylinder should be at bottom dead center.

(5) Use handle end of hammer to bump piston through compressor and into cylinder (fig. 60). Always keep compressor tightly against block while bumping piston into cylinder to prevent damage to piston rings. Do not bump piston down deep in cylinder.

(6) Position upper half of connectng rod bearing in rod, making sure locking lip rests in milled slot in rod.

(7) Pull rod down on crankshaft, using care to prevent scratching crankshaft journal with rod stud thread.

(8) Before installing bearing cap, check connecting rod bearing clearance (par. 109*e*). If clearance is within specifications, install bearing cap and tighten nuts with a torque wrench to 45 to 50 pound-feet.

109. Crankshaft

a. Removal.

(1) Remove oil pan, cylinder head, pistons, connecting rod assemblies, and timing gear cover.

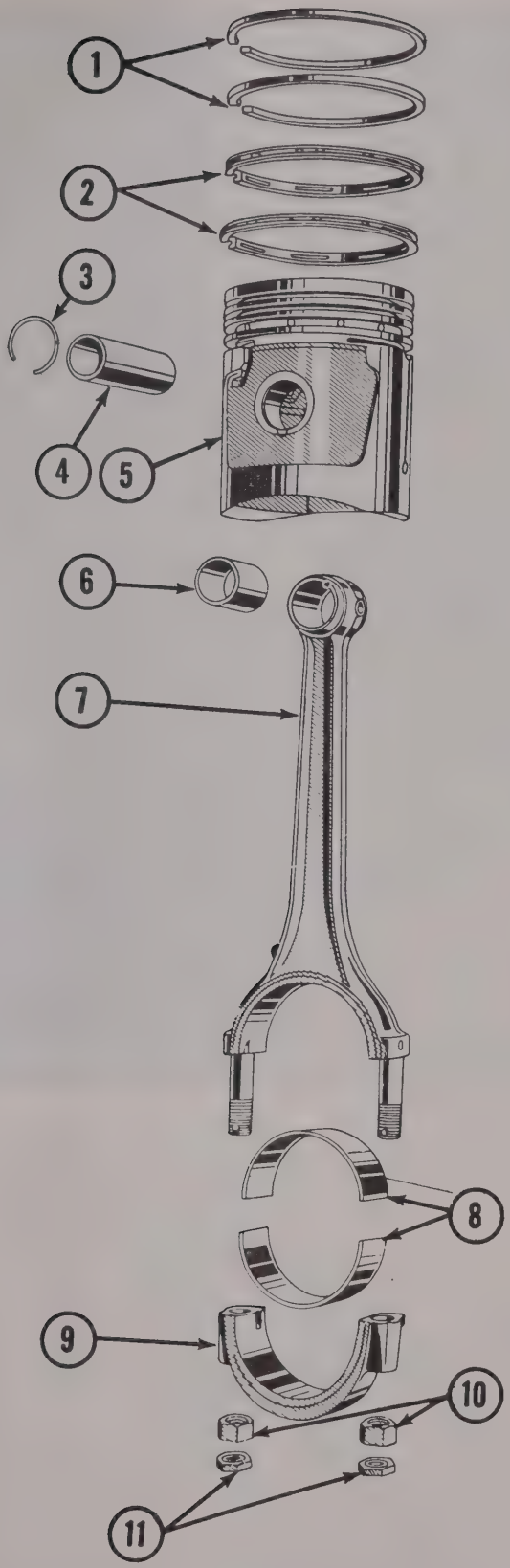


Figure 52. Piston assembly—exploded view.

1 Compression rings
2 Oil rings
3 Piston pin retainer
4 Piston pin
5 Piston
6 Connecting rod bushing
7 Connecting rod
8 Connecting rod bearings
9 Connecting rod bearing cap
10 Connecting rod stud nuts
11 Connecting rod pal nuts

Figure 52—Continued

(2) Remove main bearing caps. Make certain that they are marked for correct installation.

(3) Lift crankshaft out of block. An exploded view of the crankshaft appears as figure 61.

b. Cleaning and Inspection.

(1) Clean crankshaft in dry cleaning solvent. Blow out channels with compressed air.

(2) Examine crankshaft for evidence of cracks.

(3) Make certain dowel pins are not loose or damaged.

(4) Measure each crank pin journal for wear, out-of-round, and taper. If out-of-round is in excess of .0015 inch and taper is greater than .001 inch, crankshaft will have to be reground for next undersize bearings, or replaced. Crankshaft specifications are shown in table V.

c. Main Bearing Bore Alinement.

(1) Remove main bearing inserts.

(2) Install bearing caps and tighten cap screws to 80 to 90 pound-feet torque. Measure bearing bore size. It should be 3.0661 inches to 3.067 inches.

(3) Remove main bearing caps and install an alining bar .0075 inch under bearing bore size. Install bearing caps and tighten cap screws to proper torque.

(4) If alining bar can be turned by hand with the aid of a wrench, bore alinement is satisfactory. If bar cannot be turned, block will have to be replaced.

d. Oil Seal Installation. Soak new oil seals for at least 24 hours prior to installation. Roll seal into position in recess by using bar stock slightly smaller than diameter of crankshaft bearing. Trim ends of seal flush with pan or block.

e. Main Bearing Installation.

(1) Place one-half of bearing shell in block. Make certain shell fits properly.

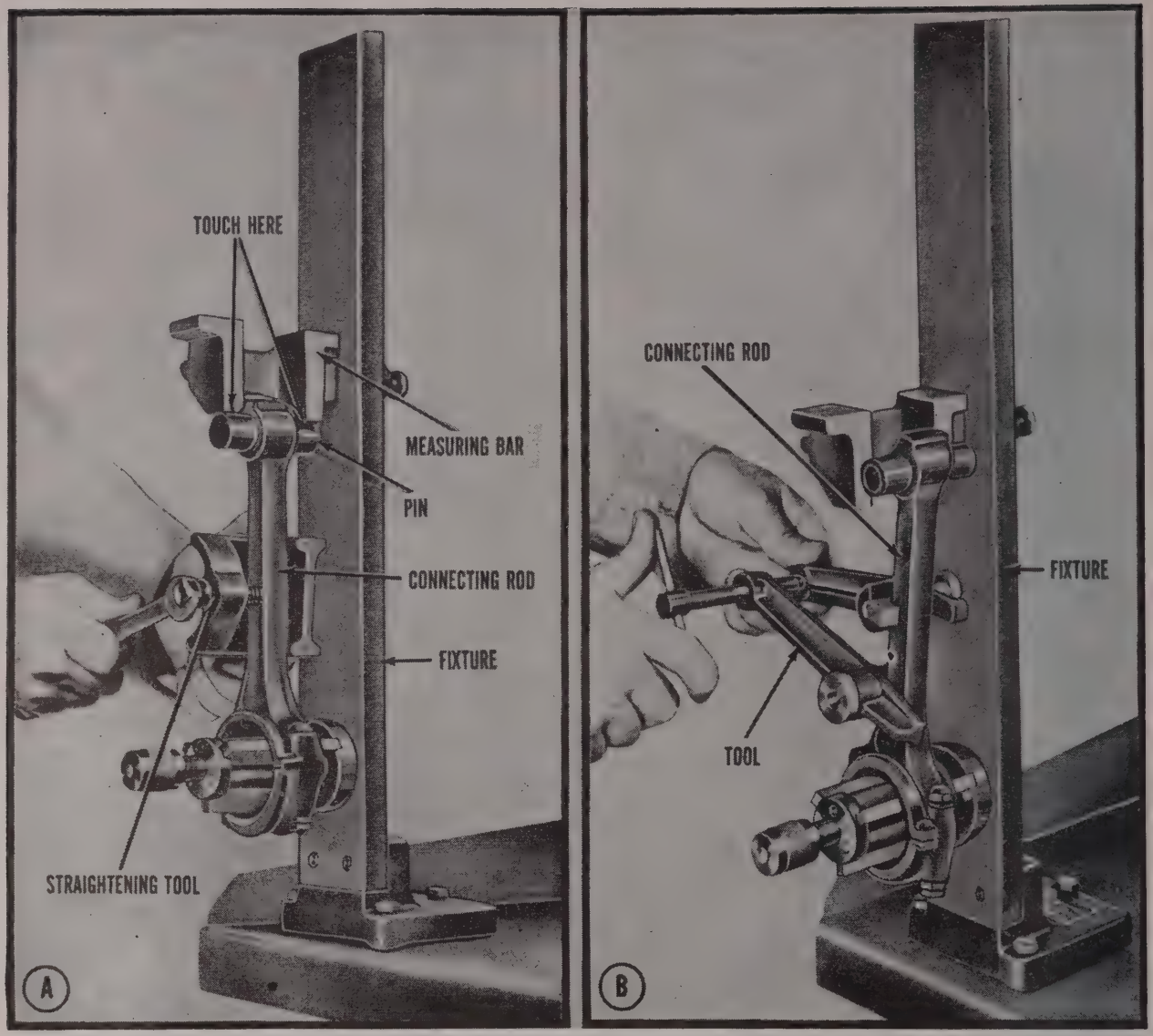


Figure 53. Checking connecting rod alinement.

(2) Hold bearing firmly in cap. Place straightedge over cap faces. Bearings should hold straightedge from bearing and cap parting line by .001 inch to .003 inch. Replace bearings if they do not do so.

(3) Place crankshaft in bearings.

(4) Place other halves of bearings in bearing caps.

(5) Coat a piece of .002-inch shim stock (½ inch wide and 1 inch long) with oil, and place it between bearing cap and crankshaft as shown in figure 62.

(6) Install bearing caps and bearing halves and tighten nuts to 80 to 90 pound-feet torque.

(7) If possible, rotate crankshaft at least one full turn. If clearance is correct, there will be a drag on the crankshaft and it will not turn by hand. If crankshaft can be turned, clearance is excessive.

(8) Remove shim stock. Crankshaft should now turn one full revolution by hand. Reinstall bearing caps. Tighten to proper torque specifications.

f. Crankshaft End Thrust.

(1) Position a heavy screwdriver or light pry bar between crankshaft and No. 3 main bearing. Pry crankshaft toward rear of engine.

(2) Insert feeler ribbon between rear thrust face of crankshaft flange and thrust flange

on rear main bearing (fig. 63). Clearance should be .004 inch to .008 inch for new crankshaft and not over .012 inch for used or worn crankshaft and bearings.

110. Water Pump

When repair involves disassembly of the water pump for inspection or replacement of internal parts, remove components in sequence as shown in figure 64. When reassembling, make certain that new gaskets are installed, that all connections are securely tightened, and that water pump does not leak.

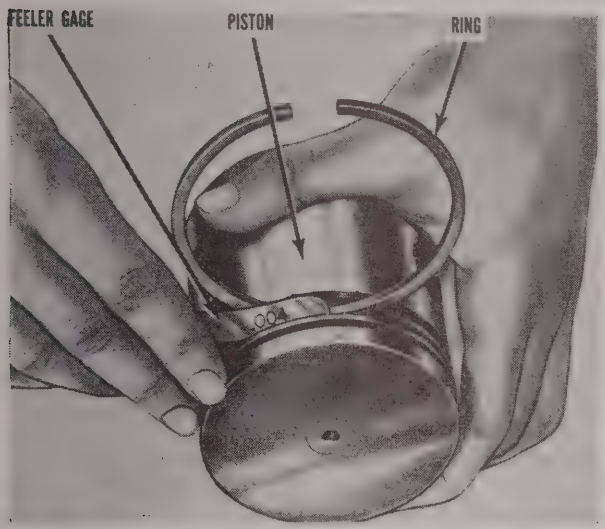


Figure 54. Checking ring side clearance.

111. Engine Specifications

The specifications contained in table V are to be used by personnel responsible for repair and reconditioning of the engine.

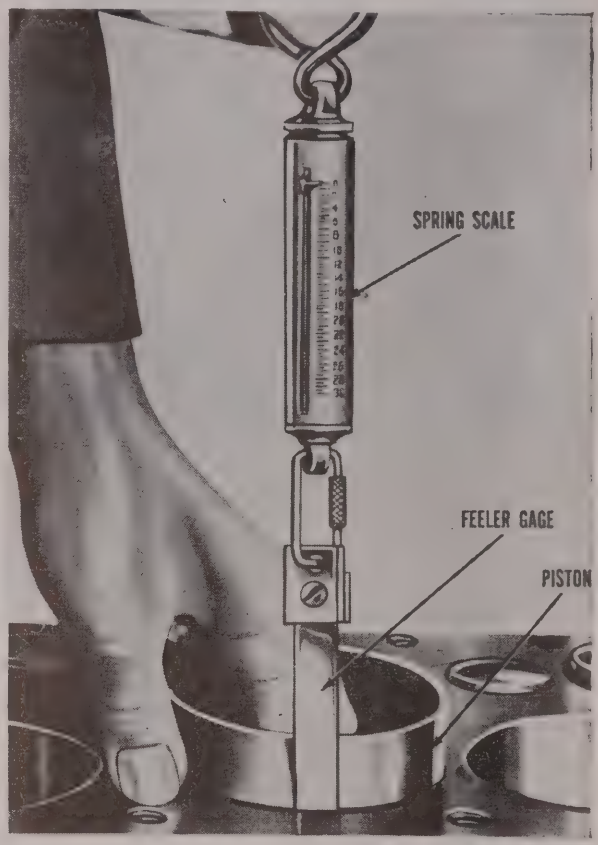


Figure 55. Fitting piston.

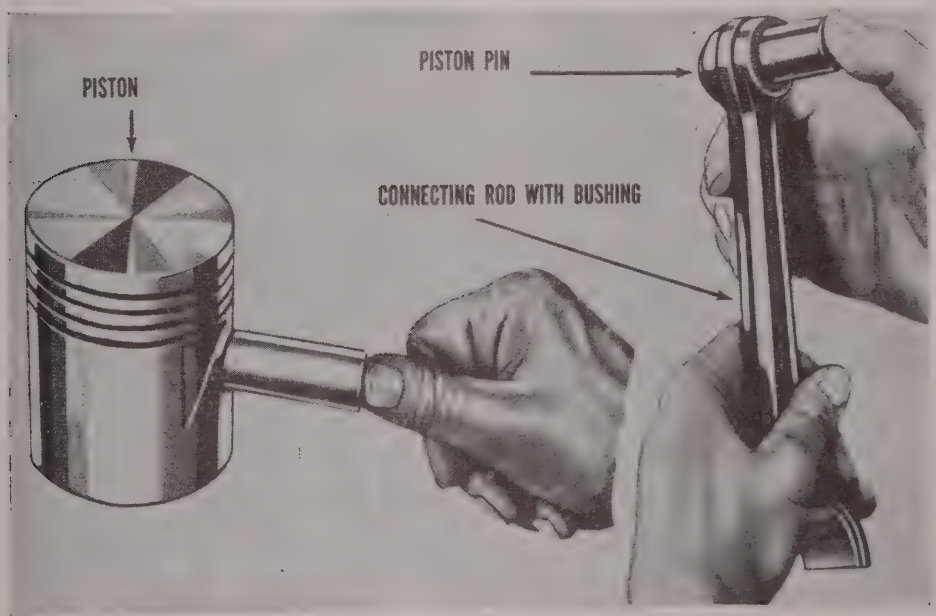


Figure 56. Fitting piston pins.

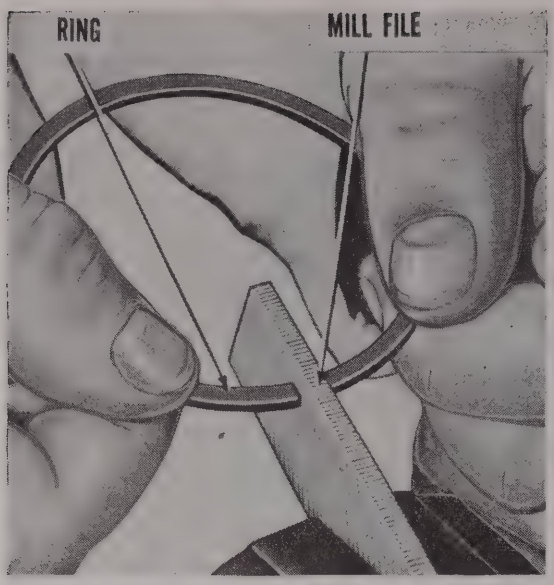


Figure 57. Filing ring gap.

Table V. Engine Specifications

Camshaft:	
Bearings:	
Inside diameter	1.928 to 1.9285 in.
Original fit tolerance	.001 to .002 in.
Wear limit before replacement.	1.9315 in.
Journal:	
Diameter	1.927 to 1.9265 in.
Type fit	Running
Wear limit before replacement.	.005 to 1.924 in.
Number of bearings	4
Connecting rod bearings:	
Clearance: Original fit tolerance.	.0004 to .0027 in.
Undersize	.002, .010, .020, and .030 in.

Table V. Engine Specifications—Continued

Connecting rods:	
Piston pin bushing (inside diameter):	
Original specification	.8503 to .8506 in.
Wear limit before replacement.	.853 in.
Side clearance on crankshaft:	
Original fit tolerance	.003 to .007 in.
Original specification	.003 to .007 in.
Wear limit before replacement.	.022 in.
Crankshaft:	
Crankshaft end thrust	.004 to .008 in.
Crankshaft runout	.002 in.
Main bearing:	
Journal diameter	2.8732 to 2.874 in.
Journal radii (fillet)	.08 to .10 in.
Maximum taper:	
Original specification	.0005 in.
Wear limit before replacement.	.001 in.
Pin diameter:	
Original specification	2.298 to 2.2988 in.
Wear limit before replacement.	.005 in.
Rods and main journals:	
Maximum out-of-round:	
Original specifications	.00025 in.
Wear limit before replacement.	.0015 in.
Cylinder block:	
Cylinder bore size	3.300 to 3.301 in.
Diameter camshaft bearing bore in block.	2.0575 to 2.0585 in.
Diameter main bearing bore in block.	3.0661 to 3.067 in.
Maximum out-of round:	
Original specification	.0005 in.
Maximum allowable	.003 in.

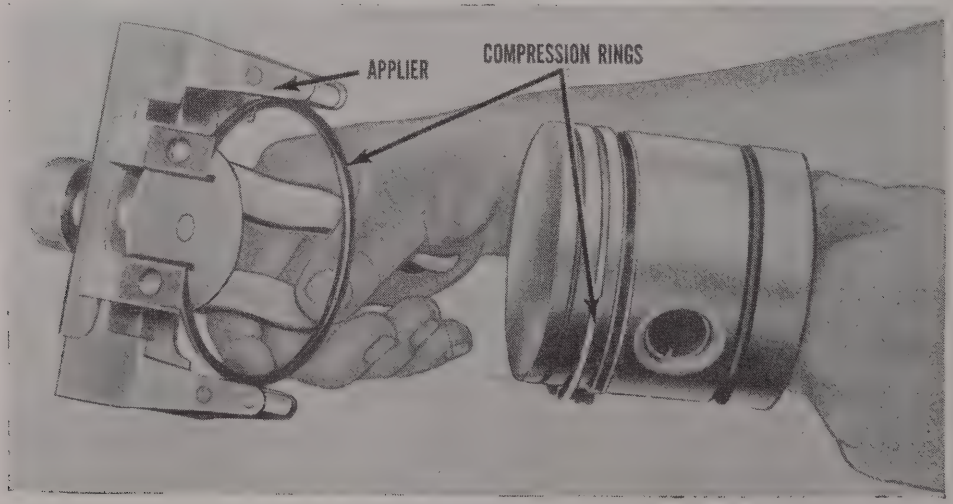


Figure 58. Installing piston ring.

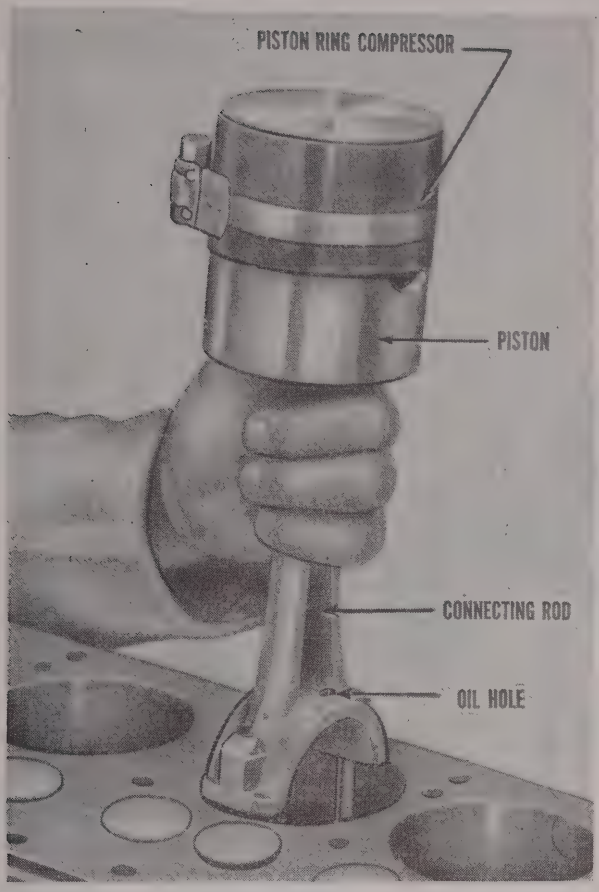


Figure 59. Installing piston and connecting rod.

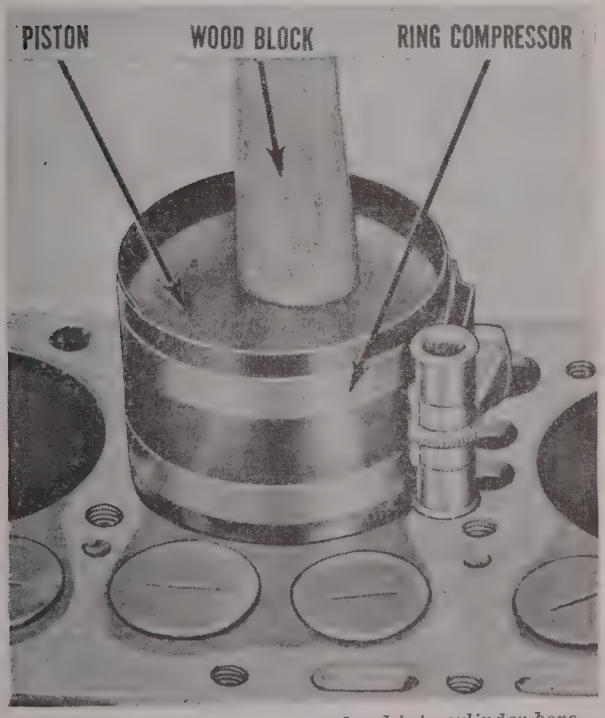
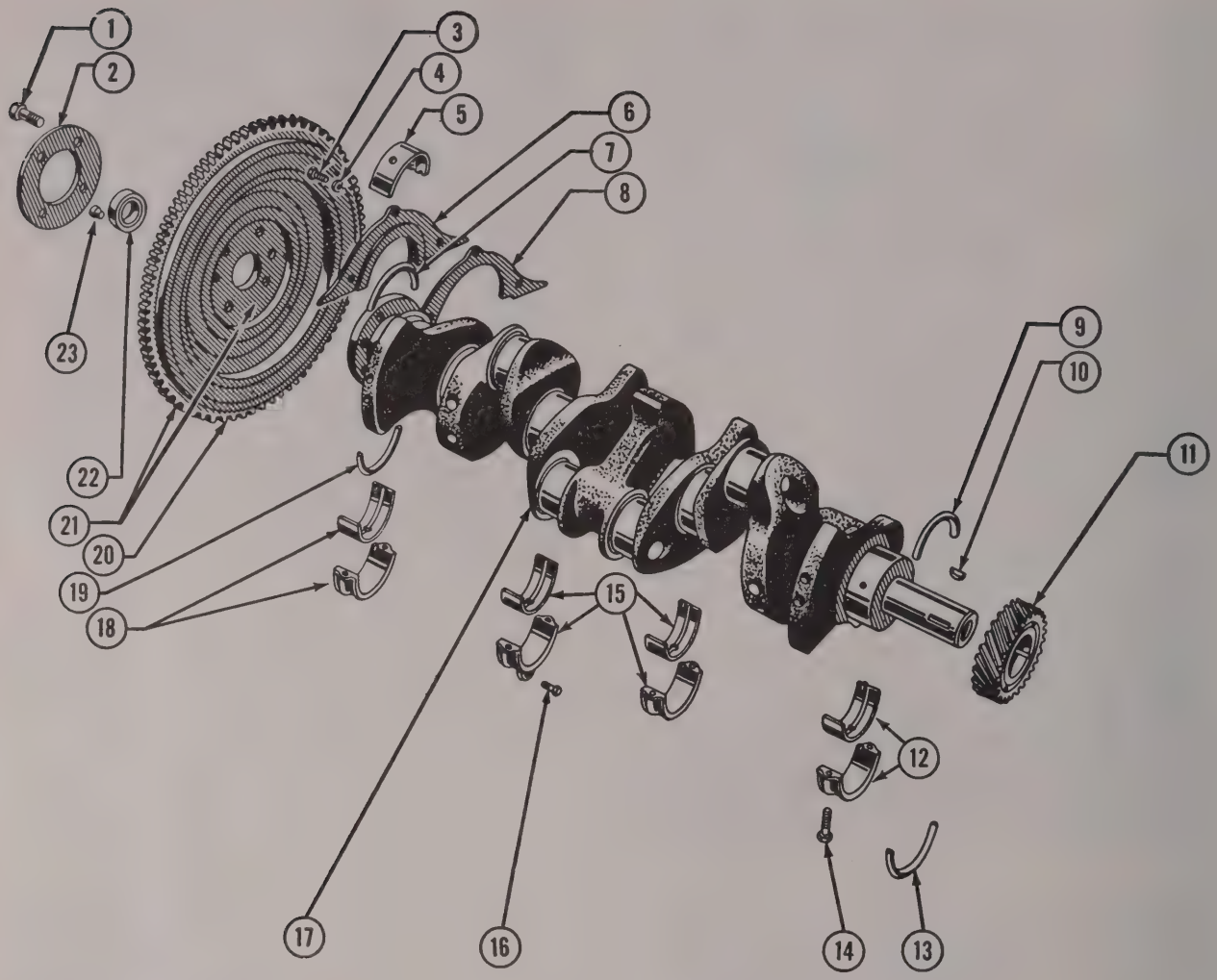


Figure 60. Pushing piston and rod into cylinder bore.

Table V. Engine Specifications—Continued

Cylinder block—Continued	
Maximum taper of cylinder bore:	
Original specification	.00075 in.
Maximum allowable	.006 in.
Oil relief valve spring tension at 1.14 in.	12–76 lb.
Valve guide bore:	
Diameter in block	.655 to .656 in.
Original fit tolerance	.0006 to .0024 in.
Flywheel:	
Pilot bearing:	
Fit in flywheel	.0015 in.
Original fit tolerance	.0015 in. (max.)
Type fit	Press
Pilot-bearing-to-transmission-shaft clearance:	
Original fit tolerance	.0027 to .0043 in.
Type fit	Running
Wear limit before replacement.	.006 in.
Runout of flywheel face after assembly:	
Original specification	.005 in.
Wear limit before replacement.	.005 in.
Runout of starter ring (lateral) gear after assembly (total indicator reading):	
Original specification	.010 in.
Wear limit before replacement.	.010 in.
Main bearings:	
Clearance	.0005 to .002 in.
Undersize	.002, .010, .020, and .030 in.
Piston pins:	
Diameter	.8501 to .8504 in.
Length	3.116 to 3.119 in.
Oversize	.001 and .002 in.
Pin clearance in rod bushing:	
Press fit	.0001 in.
Slip fit	.0003 in.
Pin in piston bore clearance:	
Press fit	.0003 in.
Slip fit	.0001 in.
Piston rings:	
End gaps:	
Oil ring	.010 to .017 in.
Second compression ring	.010 to .017 in.
Top compression ring	.010 to .017 in.
Wear limit before replacement (all rings).	.035 in.
Oversize	.020, .030, .040, and .060 in.
Ring gap spacing	120°
Vertical clearances:	
Oil ring:	
Original fit tolerance	.001 to .003 in.
Wear limit before replacement.	.005 in.



1 Flywheel mounting bolt
2 Flywheel dowel retainer
3 Rear packing retainer bolt
4 Lock washer
5 Rear main bearing
6 Rear packing retainer
7 Rear packing
8 Rear packing retainer gasket
9 Front packing
10 Crankshaft gear key
11 Crankshaft gear
12 Front main bearing
13 Oil pan packing
14 Crankshaft main bearing bolt
15 Crankshaft intermediate bearings
16 Oil pump screen cover and inlet mounting screw
17 Crankshaft assembly
18 Rear main bearing
19 Rear main bearing oil seal
20 Flywheel ring gear
21 Flywheel and ring gear assembly
22 Clutch pilot bearing
23 Flywheel dowel

Figure 61. Crankshaft and related parts—exploded view.

Table V. Engine Specifications—Continued

Piston Rings—Continued	
Vertical clearances—Continued	
Second compression ring:	
Original fit tolerance	.001 to .0025 in.
Wear limit before replacement.	.005 in.
Top compression ring:	
Original fit tolerance	.0025 to .003 in.
Wear limit before replacement.	.005 in.

Table V. Engine Specifications—Continued

Pistons:	
Clearance at bottom skirt	.0005 to .0035 in.
New piston fit in standard size cylinder bore.	.0003 in.
New piston in old bore:	
Gage thickness	.004 in.
Pull	6 to 10 lb.
Old piston in old bore:	
Gage thickness	.004 in.
Pull	6 to 10 lb.

Table V. Engine Specifications—Continued

Pistons—Continued	
Oversize	.0025, .020, .030, .040, and .060 in
Piston taper	.001 to .0015 in.
Ring groove diameters:	
Oil	.1875 to .1885 in.
Second compression	.0945 to .0955 in
Top compression	.095 to .096 in.
Valve guides:	
Diameter:	
Inside	.3420 to .3441 in.
Outside:	
Original fit tolerance	.0006 to .0024 in.
Original specifications	.6574 to .6566 in.
Type fit	Press
Valve springs:	
Tappets:	
Diameter:	
Body	.624 to .6245 in.
Bore	.625 to .6255 in.
Original fit tolerance	.0005 to .0015 in.
Wear limit before replacement.	.004 in.
Tension at 1.75 in	112 to 120 lb.
Tension at 2.109 in	47 to 53 lb.

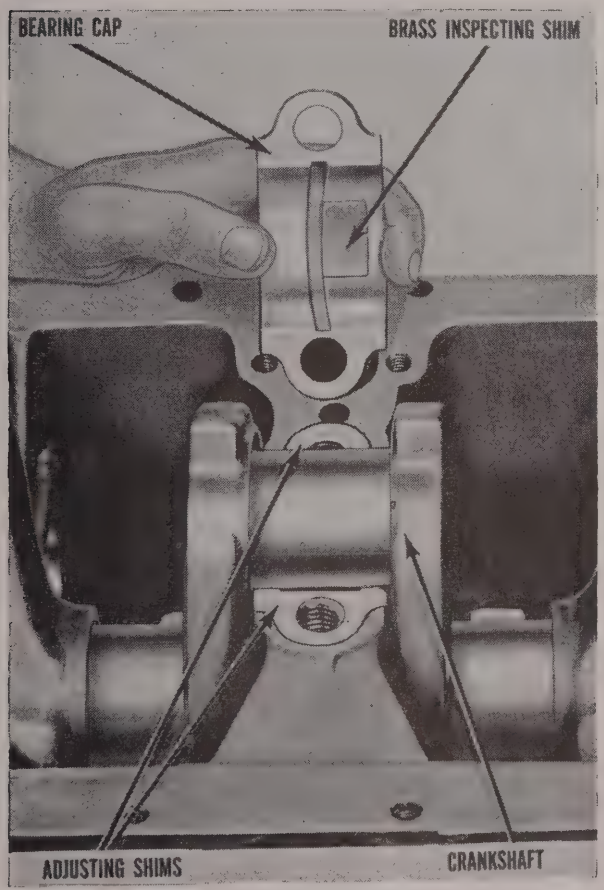


Figure 62. Fitting main bearings.

Table V. Engine Specifications—Continued

Valves:	
Diameter:	
Head:	
Exhaust	1.505 to 1.515 in.
Intake	1.647 in.
Stem:	
Exhaust	.3415 to .3405 in.
Intake	.341 to .342 in.
Wear limit before replacement.	.338 in.
Face angle	45° to 45° 15′
Face runout	.0015 in.
Lash (cold) at firing point:	
Original fit tolerance:	
Exhaust	.013 to .015 in.
Free valve clearance	.0002 to .004 in.
Intake	.009 to .011 in.
Wear limit before replacement.	.010 in.
Seat angle	44° 30′ to 45°
Seat runout (total indicator reading):	
Original specifications	.001 in.
Wear limit before replacement	.001 in.
Seat width:	
Exhaust:	
Original fit tolerance	.065 to .080 in.
Original specifications	.065 to .080 in.
Intake:	
Original fit tolerance	.065 to .080 in.
Original specifications	.065 to .080 in.

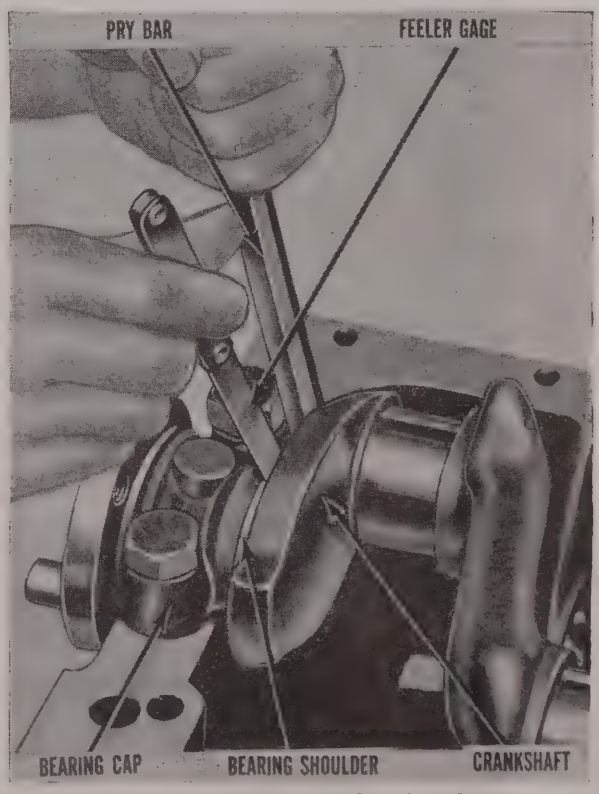
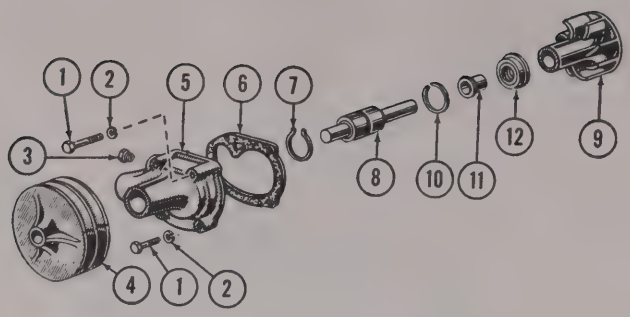


Figure 63. Checking crankshaft end play.



1 Pump housing cap screws
2 Pump housing cap screw lock washers
3 Drain plug
4 Drive pulley
5 Pump housing
6 Pump housing gasket
7 Shaft and bearing retainer snap ring
8 Shaft and bearing
9 Impeller
10 Impeller seal retainer ring
11 Impeller seal slinger
12 Impeller seal

Figure 64. Water pump—exploded view.

Section II. FUEL SYSTEM

112. Carburetor

a. Disassembly.

(1) Remove air horn as follows:
- (*a*) Remove carburetor fast idler rod clips and fast idle rod.
- (*b*) Remove the screws that hold air horn on main body and lift air horn and gasket off main body.

(2) Remove throttle body as follows:
- (*a*) Remove carburetor-accelerator-pump-to-throttle-shaft-lever retainer and lever.
- (*b*) Remove throttle-body-to-main-body screws and separate throttle body and gasket from the main body.

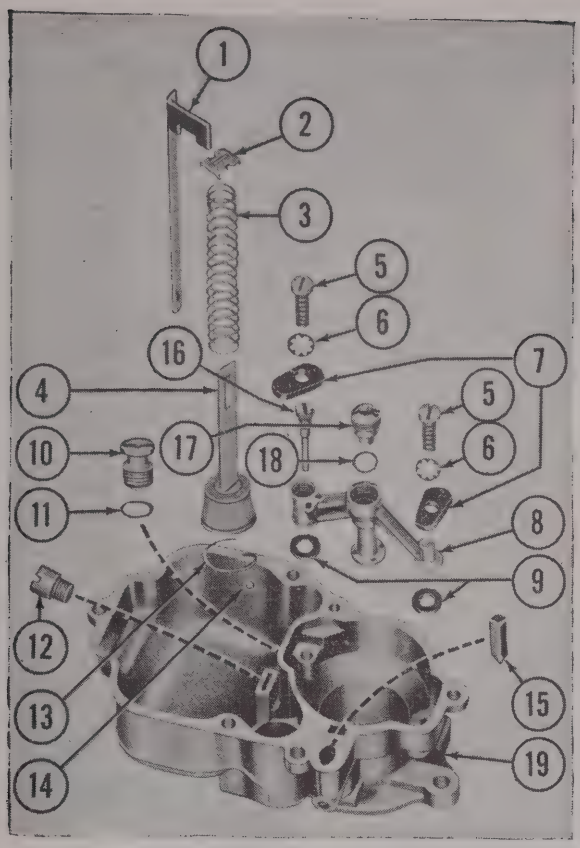
(3) Refer to figure 65 and disassemble main body as follows:
- (*a*) Lift accelerating pump assembly from main body.
- (*b*) Remove the two nozzle bar clamps and lift nozzle bar out of main body.
- (*c*) Remove the power valve.
- (*d*) Remove the main jet.
- (*e*) Remove the pump discharge valve retainer.
- (*f*) Remove the carburetor pump check ball retainer with a wire with a hook at one end.
- (*g*) Place a hand over the top of the main body, and turn the body over, being careful to catch the pump check ball and the pump discharge valve.
- (*h*) Remove the idle tube and nozzle air bleed plug from the nozzle bar.

(4) Refer to figure 66 and disassemble the air horn as follows:
- (*a*) Remove the float hinge pin and float from the air horn.
- (*b*) Lift the float needle valve from the valve seat.
- (*c*) Remove the float needle valve seat.
- (*d*) Pull the power valve piston assembly from air horn.
- (*e*) Remove the choke lever, choke lever plunger, and spring.
- (*f*) If necessary, remove the two choke plate screws, holding the choke lever in the open position, and remove the choke plate shaft and spring.

(5) Refer to figure 67 and disassemble throttle body as follows:
- (*a*) Remove the carburetor idle adjustment needle and spring.
- (*b*) If necessary, remove the throttle plate screws and slide the throttle plate out of the throttle shaft.
- (*c*) Remove the shaft nut, lock washer, and accelerator pump lever.

b. Reassembly. Install new gaskets and proceed as follows:

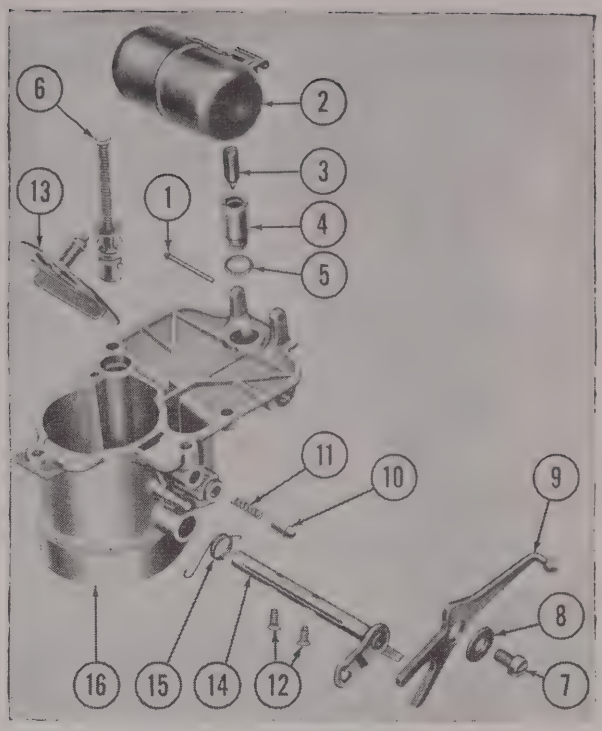
(1) Assemble air horn as follows:
- (*a*) Install the float needle valve seat and new gasket.
- (*b*) Install the choke shaft and choke shaft spring if these parts have been removed.
- (*c*) Be sure the choke shaft spring is on the peg provided on the air horn so the choke plate will remain in the closed position.
- (*d*) Place the choke plate in the shaft, and install new choke plate screws, but do not tighten the screws.
- (*e*) Centralize the valve by tapping it lightly.
- (*f*) Hold the valve in place while tightening the screws.



1 Pump operating rod
2 Pump operating rod washer
3 Pump operating rod spring
4 Pump operating rod piston
5 Nozzle bar mounting screws
6 Nozzle bar mounting screw lock washer
7 Nozzle bar clamps
8 Nozzle bar
9 Nozzle bar gaskets
10 Power valve
11 Power valve gasket
12 Main metering jet
13 Pump check ball retainer
14 Pump check ball
15 Pump discharge needle
16 Idle tube
17 Nozzle air bleed plug
18 Nozzle air bleed plug washer
19 Carburetor main body housing

Figure 65. Carburetor main body—exploded view.

(*g*) Stake the screws in place on the shaft.
(*h*) Install the choke lever, plunger, and spring on air horn.
(*i*) Place choke lever on the boss.
(*j*) Make sure the stop on choke shaft lever is in the V of the choke lever
(*k*) Install the piston and stem power valve piston assembly in the air horn.
(*l*) Install the float needle valve and float in the air horn.
(*m*) Adjust the float level to 1.322 to 1.353 inches.



1 Float lever shaft
2 Float
3 Fuel needle valve
4 Fuel needle valve seat
5 Fuel needle valve seat gasket
6 Power valve piston assembly
7 Choke lever retaining screw
8 Choke lever retaining screw washer
9 Choke lever
10 Choke lever plunger
11 Choke lever plunger spring
12 Choke plate retainer screws
13 Choke plate
14 Choke shaft and lever
15 Choke lever spring
16 Air horn

Figure 66. Carburetor air horn—exploded view.

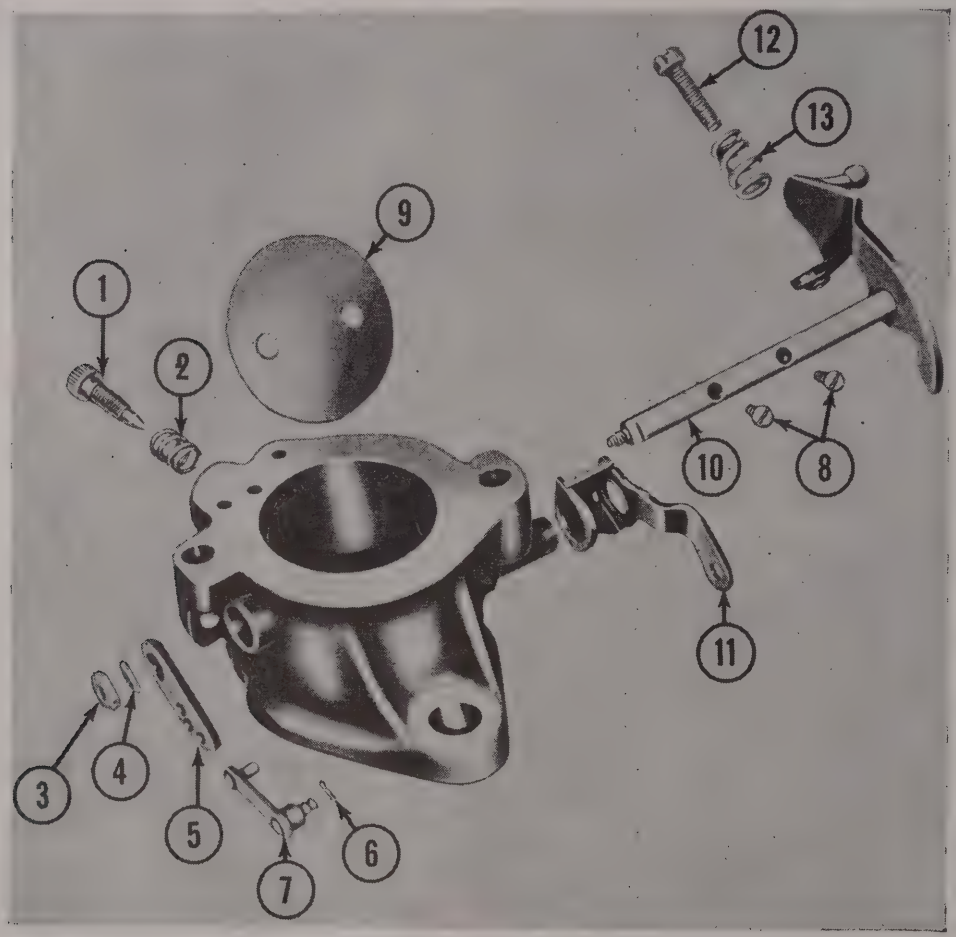
(2) Assemble main body as follows:
(*a*) Place a new gasket on the power valve and install the valve in the main body.
(*b*) Install the correct size main jet.
(*c*) Place the pump check ball in the forward hole in the pump bore.
(*d*) Install the check ball retainer in the pump bore making sure the bent end of the retainer is over the check ball.
(*e*) Install the pump discharge needle and retainer.
(*f*) Install the idle tube in the nozzle bar.
(*g*) Place a new gasket on each nozzle seat in the main body.
(*h*) Position the nozzle bar and install the nozzle bar clamps, lock washers, and screws.

(*i*) Install the air bleed plug and gasket.
(*j*) Install the pump piston assembly.

(3) Assemble throttle body as follows:
(*a*) Install the adjusting needle and spring.
(*b*) If throttle plate and shaft were removed, slide the shaft into the throttle body.
(*c*) Install the accelerating pump lever and secure with the lock washer and nut.
(*d*) Place the throttle plate in the shaft, and install new throttle plate screws, but do not tighten the screws.
(*e*) Centralize the valve by tapping it lightly.
(*f*) Hold the valve in place while tightening screws. Stake the screws.

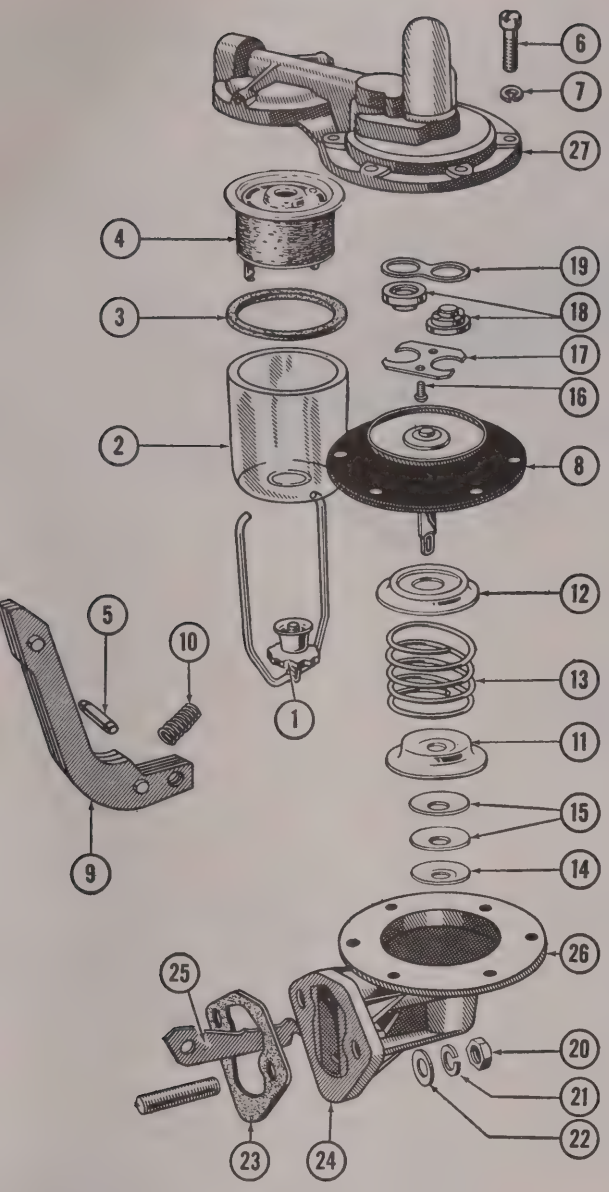
(4) Assemble throttle body to main body as follows:
(*a*) Position a new throttle body gasket on the main body and secure the throttle body to the main body.
(*b*) Insert the grooved pin of the pump link in the pump operating rod and the other pin in the pump operating lever.
(*c*) Install the pump link retainer in the groove of the pin.
(*d*) The hole farthest from the pivot point is for extreme cold temperatures. The hole nearest the pivot is for extreme hot temperatures. The center hole is for average working conditions.

(5) Assemble air horn to main body as follows:
(*a*) Position a new gasket on the main body.
(*b*) Position the air horn on the main body and secure with the screws.



1	Idle adjustment needle	6	Pump link retainer	11	Idler lever
2	Spring	7	Pump link	12	Throttle adjustment screw
3	Throttle shaft locknut	8	Throttle plate screws	13	Spring
4	Lock washer	9	Throttle plate		
5	Pump operating lever	10	Throttle shaft		

Figure 67. Carburetor throttle body—exploded view.



1 Bail assembly
2 Filter bowl
3 Gasket
4 Strainer
5 Rocker arm pin
6 Screw
7 Lock washer
8 Diaphragm
9 Rocker arm
10 Rocker arm return spring
11 Push rod retainer
12 Spring seat
13 Spring
14 Washer
15 Oil seals
16 Screw
17 Valve plate
18 Valve
19 Gasket
20 Stud nut
21 Lock washer
22 Flat washer
23 Stud
24 Gasket
25 Rocker arm link
26 Lower body assembly
27 Upper body assembly

Figure 68. Fuel pump—exploded view.

Figure 68—Continued

(*c*) Be sure to install the choke control bracket under the rear screw.

(*d*) Install the idle lever on the throttle body.

(*e*) Install a cotter pin to secure the lever in place.

(*f*) Connect the fast idle rod to the choke shaft lever.

(*g*) Connect the idle lever to the fast idle rod.

113. Fuel Pump

When repair involves disassembly of the fuel pump for inspection and replacement of parts, remove components in sequence as shown on figure 68. After pump has been reassembled, it should be subjected to a pressure and vacuum test. Pressure reading on gage should be 4 to 5 pounds per square inch. Pump capacity should be 17 gallons of fuel per hour. The reading on a vacuum gage, used in connection with the pressure test, should indicate at least 10 inches of vacuum.

Section III. LUBRICATING SYSTEM

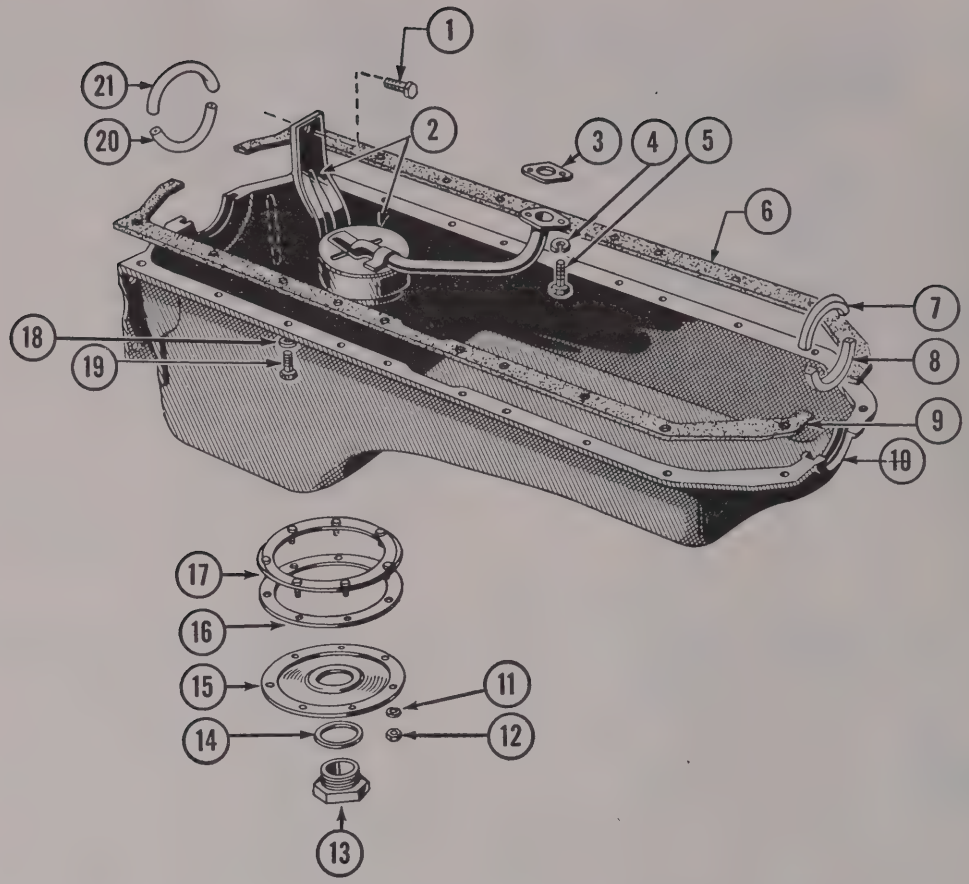
114. Oil Pan

a. Cleaning and Inspection. Use dry cleaning solvent to remove sludge and dirt from both inside and outside of oil pan. Scrape old gasket flange. Clean oil pump inlet screen. Inspect drain plug threads for damage. Check oil pump screen and inlet tube for restrictions in passages. An exploded view of the oil pan, showing parts to be inspected, appears as figure 69.

b. Oil Seal Replacement. Remove the oil packing and clean the packing retainer grooves. Soak packing in oil for about 2 hours before installation. Install short packing in front retainer groove and long packing in rear retainer grooves. Install packing, using a round bar. Make sure that packing meets gasket evenly.

115. Oil Pump

a. Disassembly. When repair involves disassembly of the oil pump for inspection and replace-



1 Inlet tube bracket cap screw
2 Cover and inlet tube assembly
3 Gasket
4 Lock washer
5 Cap screw
6 Oil pan gasket
7 Front cover oil seal
8 Front packing
9 Oil pan gasket
10 Oil pan
11 Lock washer
12 Nut
13 Drain plug
14 Drain plug gasket
15 Cleanout plate
16 Gasket
17 Cleanout plate reinforcement
18 Cap screw
19 Lock washer
20 Rear oil pan packing
21 Bearing cap oil seal

Figure 69. Oil pan and parts—exploded view.

ment of parts, remove components in sequence as shown in figure 70.

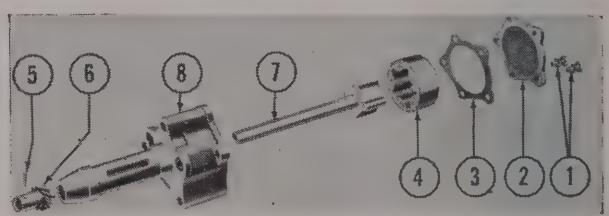
b. Inspection.

(1) Check clearance of rotors by placing straightedge over housing and inserting feeler ribbon between top of rotor and straightedge. Replace pump body or rotors if clearance of .001 inch to .005 inch cannot be maintained with a compressed gasket. When a new gasket is installed, clearance should be .0035 inch to .008 inch. Always replace rotors in pairs.

(2) Check clearance between outer rotor and oil pump body, using a feeler ribbon. Clearance should not exceed .005 inch to .010 inch.

(3) Check clearance between inner and outer rotor with feeler ribbon. Clearance should be .002 inch to .009 inch.

(4) Check clearance between pump drive shaft and housing; clearance should be .0015 inch to .0029 inch.



1 Cover cap screws and washers
2 Cover
3 Cover gasket
4 Outer rotor
5 Driven gear locking pin
6 Driven gear
7 Inner rotor and shaft
8 Body

Figure 70. Oil pump—exploded view.

c. Reassembly. When reassembling the oil pump, install parts in reverse order of disassembly. Make certain that ends of pin do not extend beyond face of rotor. Make certain new cover gasket is installed. Tighten cap screws to 7 to 10 pound-feet torque.

Section IV. ELECTRICAL SYSTEM

116. Specifications

The specifications in table VI are to be used by repair personnel when repair, inspection, or adjustment of electrical units is necessary.

Table VI. Electrical Unit Specifications

Distributor:	
Break arm spring tension	17 to 20 oz.
Point gap	.024 to .026 in.
Rotor gap	.002 to .0105 in.
Shaft end play	.002 to .005 in.
Timing	Top dead center
Generator:	
Amperage	30 (max.)
Brushes	2
Brush length	.86 in.
Maximum output	Attained at 1,650 r. p. m.
Spark plug:	
Gap	.025 to .028 in.
Size	14 mm.
Torque	24 to 30 ft. lb.
Starting motor:	
Brushes	2
Brush spring tension	20 to 22 oz.
No-load test	45 to 60 amperes
Voltage regulator:	
Air gaps:	
Cutout:	
Contact point	.012 to .020 in.
Core-to-armature (points closed).	.009 to .013 in.
Voltage and current limiter: Armature-to-core (closed).	.033 to .036 in.
Amperes	15

117. Generator

a. Armature Replacement.

(1) Remove the two through bolts and the brush end plate. Slide the armature and front end plate assembly out of the frame. Clamp the armature in a vise equipped with soft jaws and remove the retaining nut, lock washer, pulley, and Woodruff key. Slide the drive end plate off the shaft.

(2) Install the front end plate on the new armature. Install the Woodruff key, pulley, lock washer, and retaining nut. Slide the armature and front end plate assembly into the frame, alining the dowel with the frame slot. Retract the brushes until the brush springs ride against the side of the brushes and install the brush end plate. Install through bolts and lock washers.

b. Commutator Service.

(1) Check the commutator for runout, using V blocks as shown in figure 71. If surface of commutator is rough or more than .001 inch out-of-round, it must be turned down on a lathe or with an undercutting tool as shown in figure 72.

(2) After the commutator has been turned down, undercut mica between bars one-thirty second of an inch below copper as shown in figure 73. Polish commutator with No. 00 sandpaper.

c. Brush Replacement. Replace generator brushes when they are worn to one-half inch. Always change both brushes when replacement is required.

(1) Remove the two through bolts from the generator frame. Remove the brush end plate, armature, and front end plate assembly from the generator frame. Disconnect brush terminals and remove brushes. Clean brush end plate. Replace insulation between brush holders and end plate. Replace the armature terminal and end plate, if necessary. Make sure new brushes slide freely in holders. Seat new brushes with No. 00 sandpaper as shown in figure 74. Hold end plate to keep it from turning. Pull sandpaper in direction of armature rotation.

(2) Retract the brushes until brush springs ride against side of brushes. Install armature, front end plate assembly, and brush end plate. Install through bolts and lock washers. Lubricate brush end plate.

d. Disassembly. Refer to figure 75 and proceed as follows:

(1) Remove through bolts.

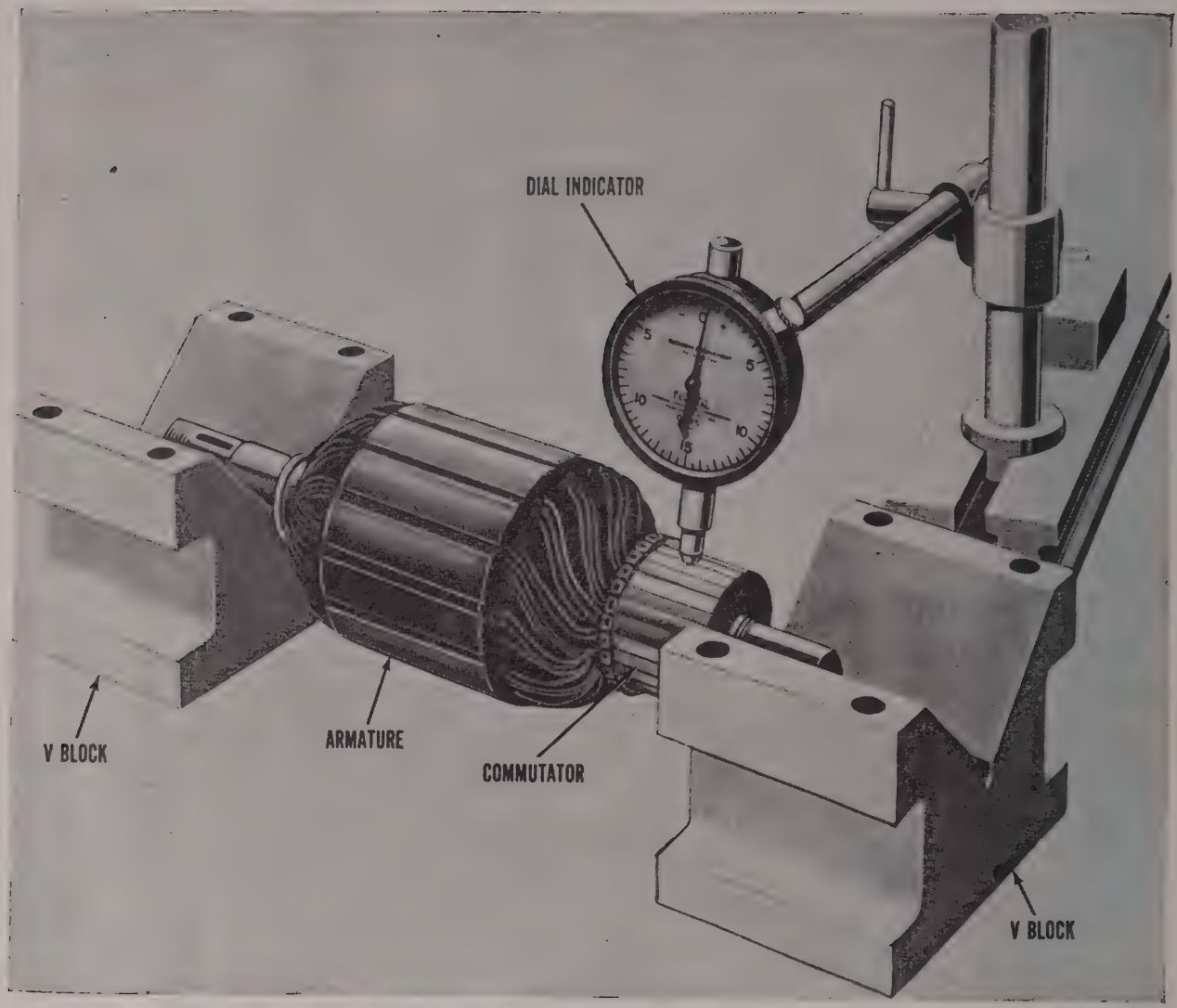


Figure 71. Checking commutator runout.

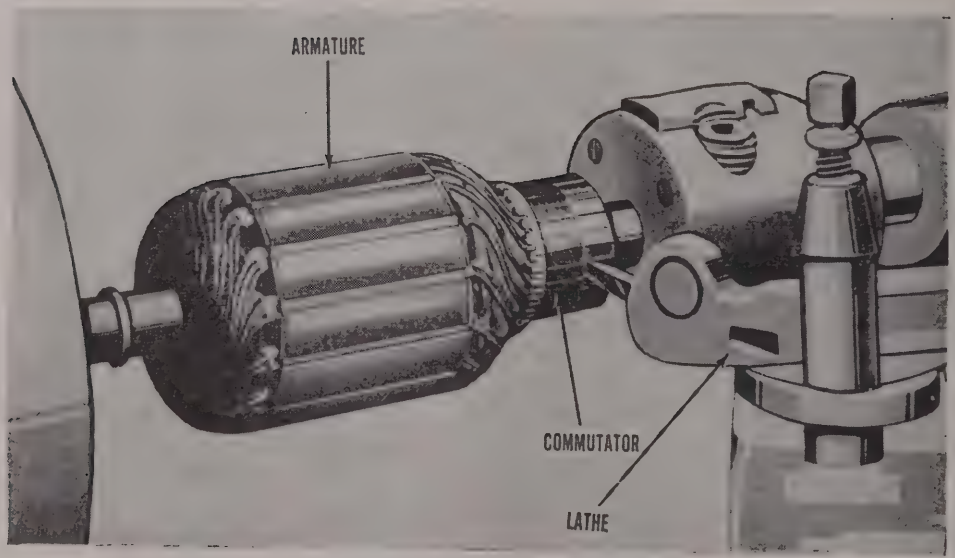


Figure 72. Turning commutator.

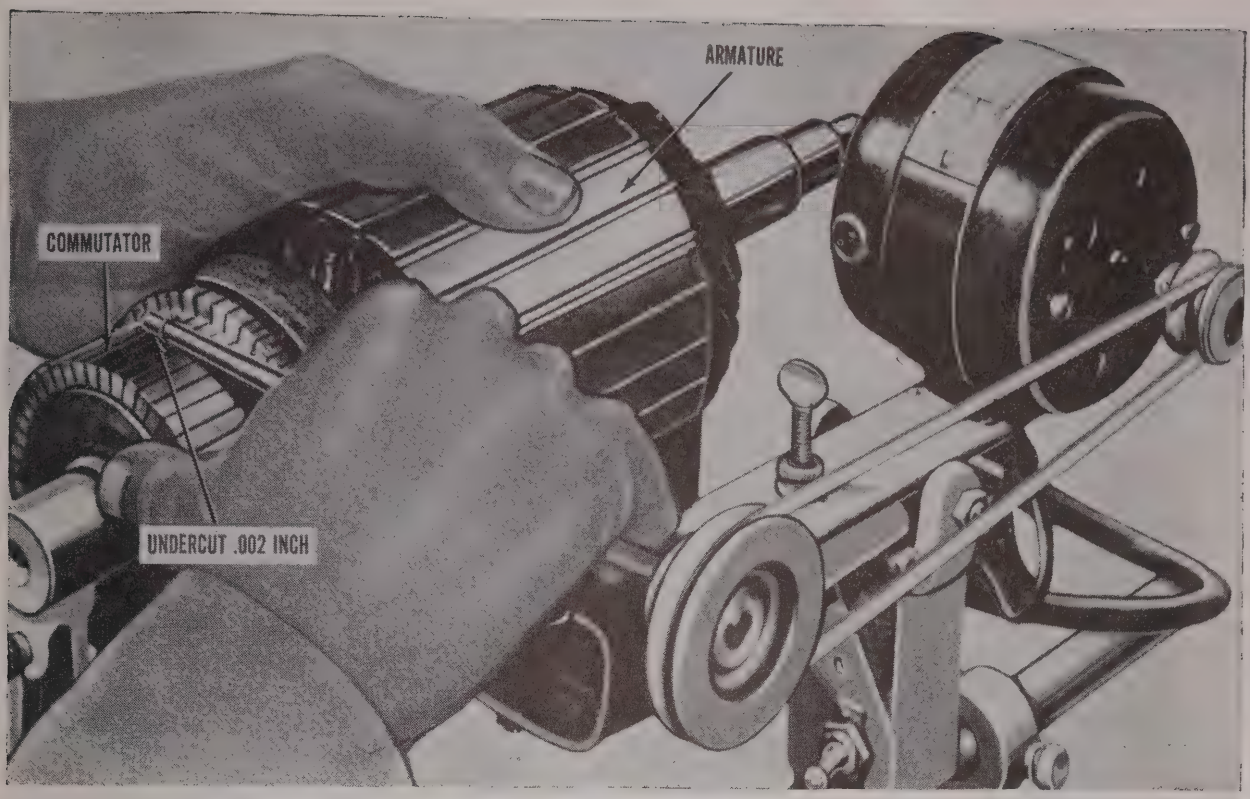


Figure 73. Undercutting mica.

(2) Remove brush end plate.
(3) Slide armature out the other end of frame.
(4) Clamp armature in soft-jawed vise and remove retaining nut, lock washer, pulley, and Woodruff key. Remove front end plate.
(5) Pry out bearing stop ring. Remove bearing from front end plate.
(6) Remove armature terminal screw and negative brush from brush end plate. Remove ground brush screw and ground brush.
(7) Remove field and ground terminal screws from generator frame and unscrew pole shoe screws as shown in figure 76. Slide the pole shoes and field windings out of the frame.

e. Reassembly. Reverse procedure in *d* above. Strike the frame several sharp blows with a soft hammer as the pole shoe screws are being installed to seat and align the pole shoes.

118. Starting Motor

a. Armature Replacement.

(1) Remove the starter drive, through bolts, rear end plate, and cover band. Remove armature.
(2) Pull brushes from their holders. Slide in the armature. Install rear end plate and through bolts. Replace brushes in holders and center brush springs on brushes. Install starter drive.

b. Commutator Turning. Check commutator runout. If commutator is more than .002 inch out-of-round, turn down commutator in a lathe or with a turning tool. Polish commutator with No. 00 sandpaper. It is not necessary to undercut mica.

c. Brush Replacement. Replace starter brushes when they are worn to .33 inch in length. Always change complete set of brushes when replacement is required.

(1) Loosen and remove cover band. Remove through bolts from starter frame. Remove brushes from holders. Remove brush end plate and armature rear end plate assembly. Unsolder brush leads from field coils. Unscrew brush terminal screws. Remove ground brushes.
(2) Clean brush end plate. Replace end plate if insulation between brush holder

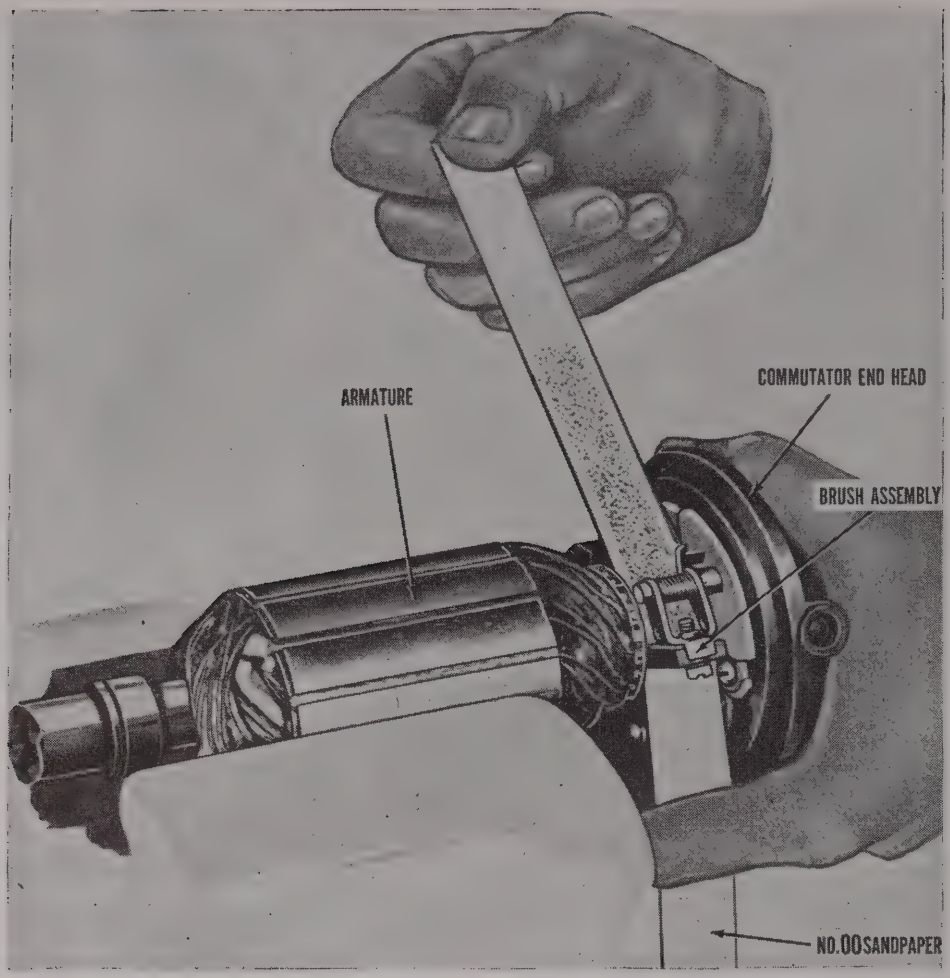


Figure 74. Seating brushes.

and end plate is damaged or cracked.

(3) Make certain that new brushes slide freely in holders; seat new brushes, using No. 00 sandpaper.

(4) Solder new field brushes to field coils. Connect new ground brushes to starter frame with terminal screws. Install brush end plate. Slide armature rear end plate assembly into position. Make certain that the dowels in both brush end plate and rear end plate are located in the slots on starter frame.

(5) Install through bolts. Place brushes in holders. Center spring on brushes. Install cover band and tighten clamp screw.

d. Disassembly. Refer to figure 77 and proceed as follows:

(1) Remove starter drive, through bolts, and rear end plate.

(2) Remove armature; remove cover band.

(3) Remove brushes from holders and remove brush end plate.

(4) Unscrew ground brush screws and remove ground brushes.

(5) Remove nut and washers from terminal.

(6) Unscrew field pole screws. Remove pole shoes and field coils. It will be necessary to collapse the field coils to remove starter terminal screw.

(7) Unsolder terminal screw from field coils.

e. Assembly. Reverse procedure in *d* above.

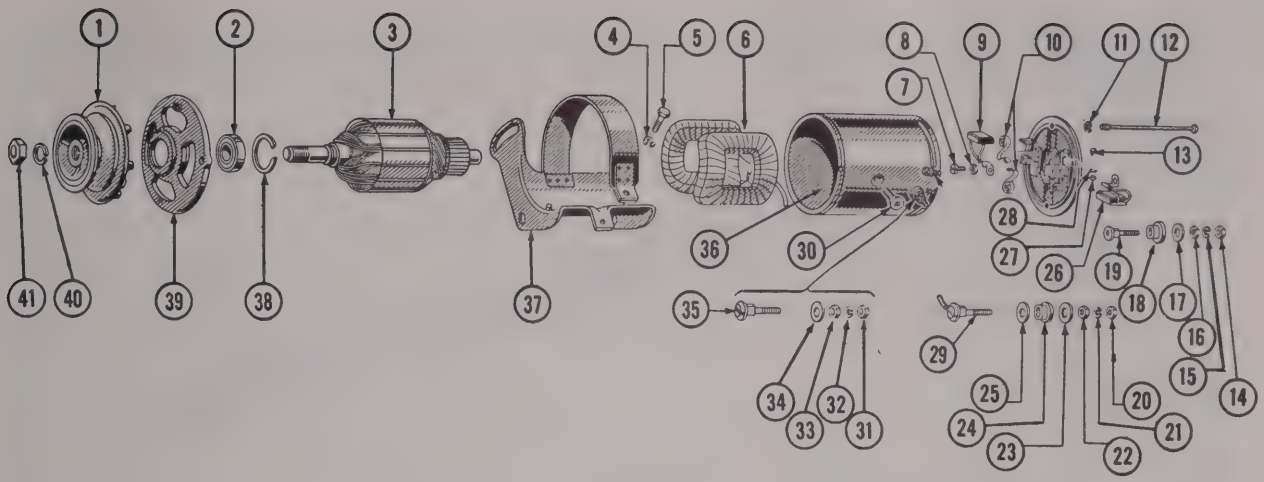
119. Starter Drive

a. Removal.

(1) Remove two spring screws, drive head, and drive spring from shaft.

(2) Remove Woodruff key and shaft and pinion assembly.

b. Disassembly. Refer to figure 78 and remove drive from shaft.



1 Pulley
2 End plate bearing
3 Armature
4 Lock washer
5 Mounting support clamping cap screw
6 Field coil assembly
7 Brush holder screw
8 Lock washer
9 Brush assembly
10 Brush springs
11 Lock washer
12 Through bolt
13 Rear end plate oil cup
14 Terminal screw nut
15 Lock washer
16 Terminal screw lock nut
17 Flat washer
18 Terminal screw bushing
19 Terminal screw
20 Terminal screw nut
21 Lock washer
22 Terminal screw lock nut
23 Flat washer
24 Terminal screw outer insulator
25 Terminal screw inner insulator
26 Brush assembly
27 Oil wick plug
28 End plate locating dowel
29 Terminal screw
30 Pole piece screw
31 Terminal screw nut
32 Lock washer
33 Terminal screw lock nut
34 Flat washer
35 Terminal screw
36 Generator frame
37 Mounting support
38 End plate bearing snap ring
39 Front end plate
40 Pulley lock nut washer
41 Pulley lock nut

Figure 75. Generator—exploded view.

c. Reassembly.

(1) Replace shaft and pinion.
(2) Install Woodruff key, drive head, spring, lock washers, and screws.

120. Regulator

Limit disassembly of regulator to removal of cover, gasket, and contact springs.

a. Voltage Regulator Unit Check.

(1) Connect regulator to generator and a fully charged battery of proper capacity.
(2) Connect a voltmeter from regulator B terminal to regulator base and connect an ammeter in series in charging circuit at B terminal.
(3) Increase generator speed slowly until generator output is 10 amperes; note voltage setting and temperature reading. Take final reading after regulator has operated for 15 minutes with cover in place and with the generator charging at 10 amperes.

b. Voltage Regulator Unit Adjustment.

(1) Disconnect regulator and check armature air gap with a pin gage on contact side of armature stop pin in winding core by placing pin gage as close as possible to armature stop pins.
(2) Connect a three-candle-power test light and a 6-volt battery in series with the regulator F terminal and regulator base. With points open, the light will dim or go out; with the points closed, the light will burn.
(3) With a low limit pin gage in place, push armature down; light should dim or go out.
(4) With a high limit pin gage in place, push armature down; light should stay on.
(5) Adjust air gap by slightly loosening screw that holds upper bracket; raise or lower contact bracket as required.
(6) Tighten screw after adjustment is complete; recheck adjustment after screw has been tightened.
(7) Adjust voltage setting by bending lower spring arm to increase or decrease spiral spring tension.
(8) Replace the cover and stop the generator after each change of adjustment.
(9) Start generator and adjust speed to provide charging rate of 10 amperes.

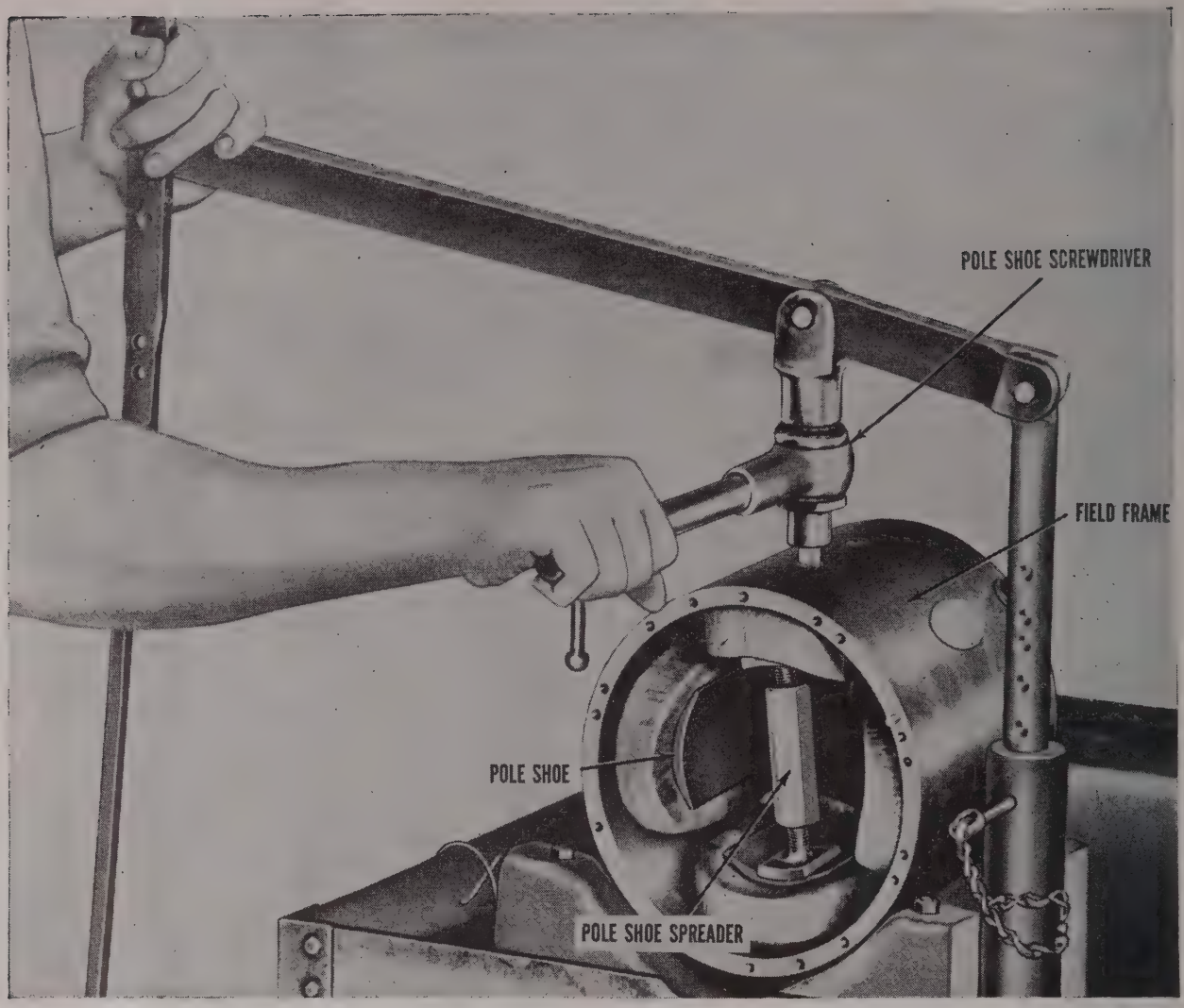


Figure 76. Removing pole shoe screws.

c. Current Limiting Regulator Check.

(1) Inspect and adjust voltage regulator current limiter setting with same meter connections as used in *b* above, with addition of an electrical load placed across the battery that will be somewhat above the current setting of the current limiter.

(2) Increase generator speed and note current setting.

(3) Current setting must be within plus or minus 5 percent of the current setting indicated on the regulator name plate.

d. Current Limiting Regulator Unit Adjustment.

(1) Check armature air gap and adjust gap to .020 inch.

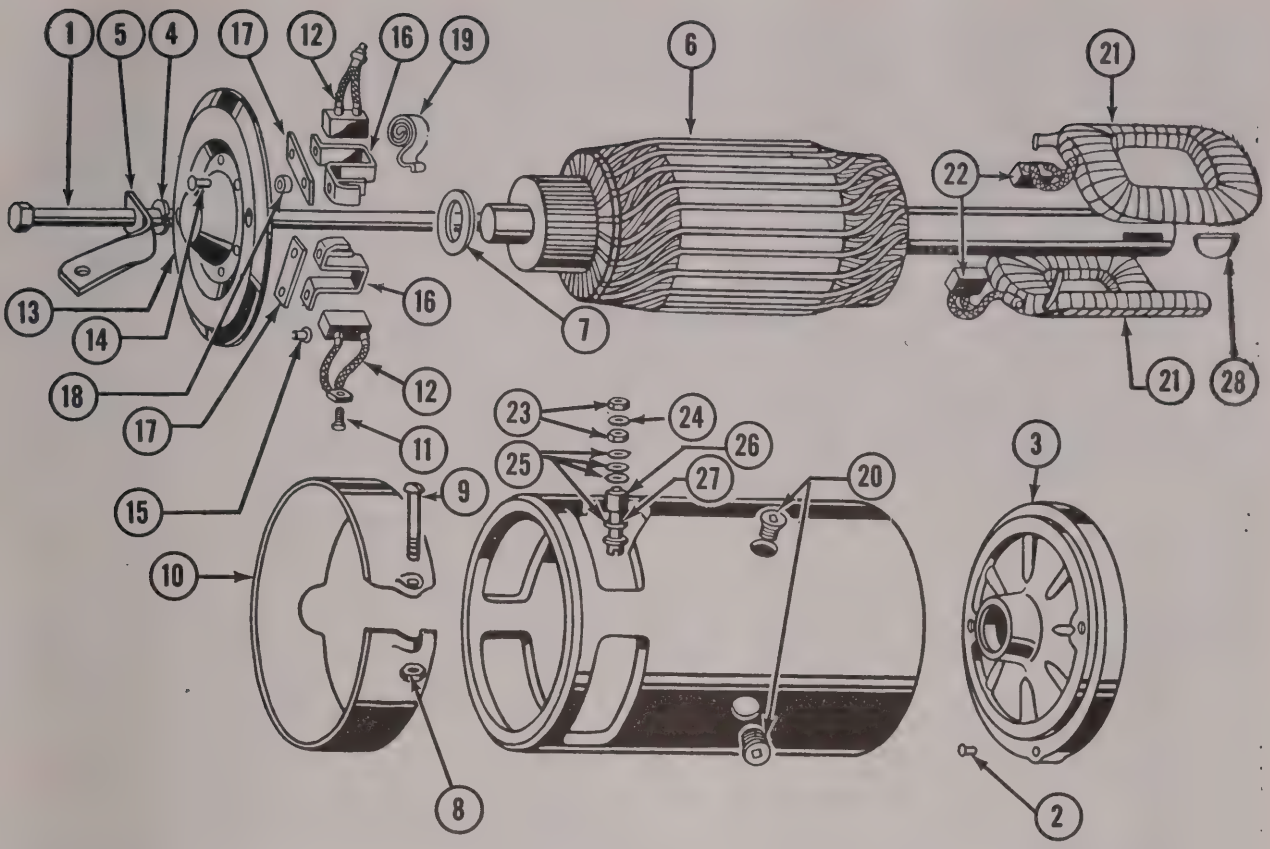
(2) Check contact gap with armature held down against the stop pin.

(3) Excessive variation from specifications indicates wrong length of armature stop pin; replace unit.

(4) Adjust current setting by bending lower spring bracket. Bending spring bracket down to increase spiral spring tension increases the current setting; bending up lowers the current setting.

121. Distributor

When repair involves disassembly of distributor for inspection and replacement of parts, refer to figure 79 and remove parts in numerical sequence.



1	Through bolt	11	Brush screw	21	Field coils
2	Dowel	12	Brushes	22	Field brushes
3	Rear end plate	13	Front end plate	23	Field terminal nuts
4	Lock washer	14	Brush holder rivet	24	Lock washer
5	Starter-to-oil-pan attaching bracket	15	Dowel	25	Insulating washers
6	Armature	16	Brush holders	26	Insulator bushing
7	Thrust washer	17	Brush holder insulators	27	Field terminal
8	Nut	18	Brush holder rivet insulator	28	Key
9	Cover band screw	19	Brush spring		
10	Cover band	20	Pole shoe screws		

Figure 77. Starting motor—exploded view.

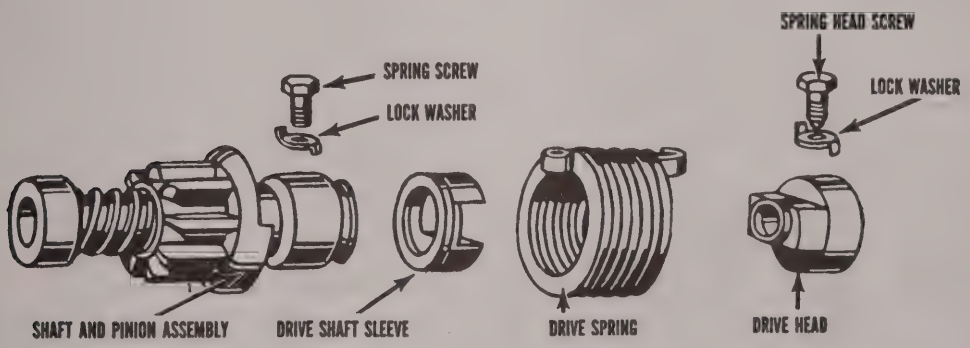
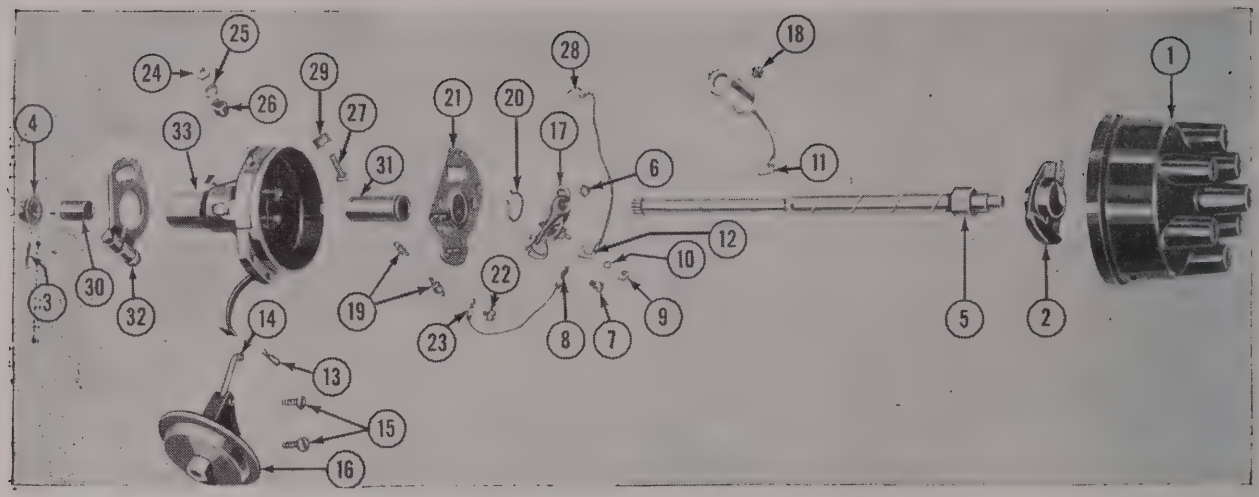


Figure 78. Starter drive—exploded view.



1 Distributor cap
2 Rotor assembly
3 Collar rivet
4 Collar
5 Shaft and cam assembly
6 Breaker arm and contact assembly mounting screw
7 Ground wire and breaker arm and contact assembly mounting screw
8 Ground-wire-to-breaker-arm and contact assembly lead
9 Primary terminal lock nut
10 Primary terminal lock nut washer
11 Condenser-to-primary-terminal lead
12 Primary-wire-to-primary-terminal lead
13 Vacuum unit rod hairpin retainer
14 Vacuum unit rod
15 Vacuum unit diaphragm assembly mounting screws
16 Vacuum unit diaphragm assembly
17 Breaker arm and contact assembly
18 Condenser mounting screw and lock washer
19 Breaker plate return springs
20 Breaker plate lock ring
21 Breaker plate
22 Ground-wire-to-distributor-housing mounting screw and lock washer
23 Ground-wire-to-distributor housing lead
24 Primary-to-coil-terminal lock nut
25 Primary-to-coil-terminal lock washer
26 Primary-to-coil-terminal outer bushing
27 Primary-to-coil-terminal bolt
28 Primary-wire-to-coil lead
29 Primary-to-coil-terminal inner insulator
30 Distributor shaft lower bushing
31 Distributor shaft upper bushing
32 Timing arm assembly
33 Unit housing

Figure 79. Distributor—exploded view.

Section V. POWER TRAIN

122. Main Transmission

a. Disassembly. Refer to A, figure 80 and proceed as follows:

(1) Remove six cap screws, control cover, and gasket.

(2) Remove cotter pin, lock nut, and lock washer from main shaft at front end of transmission; remove universal joint companion flange.

(3) Remove cap screws and washers and remove transmission support bracket.

(4) Pull out main drive shaft and bearing, using gear puller. Place hand beneath selector sliding gears as main drive shaft is removed from the transmission case and remove sliding gears.

(5) Pull out main drive gear, main drive shaft, and bearing, using gear puller.

(6) Remove snap ring and remove main drive shaft bearing; slide off main drive gear bearing.

(7) Drive out gear cluster shaft, using brass drift; remove gear cluster and shake out two bearing cages and spacer.

b. Reassembly. Reverse procedure in *a* above. If inspection reveals that clearance between mainshaft splines and gears exceeds .005 inch, or if mainshaft is twisted or scored, new parts should be installed. Other tolerances are built in and no adjustment is necessary.

123. Reverse Transmission

a. Disassembly. Refer to B, figure 80 and proceed as follows:

(1) Remove five cap screws and washers and remove transmission clutch housing.

(2) Remove four cap screws and transmission cover and shifter fork.

(3) Remove four cap screws and main drive bearing retainer.
(4) Remove four cap screws that secure reverse transmission case to main transmission case.
(5) Press out main drive gear and bearing.
(6) Remove safety wire and lock plate that hold reverse gear cluster shaft in place and press out shaft.
(7) Clip safety wire and remove lock plate that holds idler gear in place and press out idler gear shaft.
(8) Remove forward-reverse sliding gear, reverse gear cluster, and reverse idler gear.
(9) Remove two snap rings from main drive bearing and drive gear bearing.

b. Reassembly.

(1) Reinstall snap rings.
(2) Place reverse gear cluster and reverse idler gear in housing and work into position where shafts may be installed, to mount the gears.
(3) Press in shafts and secure with lock plates; tighten lock plate screws and secure with safety wires.
(4) Position forward-reverse gear (sliding gear) and install assembly on main transmission case, using new gasket, and secure with four cap screws and washers.
(5) Install main drive gear and bearing in rear of case.
(6) Install main drive gear bearing retainer and secure with four cap screws and washers.
(7) Install clutch bell housing on reverse transmission case with five cap screws and washers. Tighten securely.
(8) Check clearance between clutch driven plate and input shaft splines. If clearance between hub and shaft exceeds .005 inch, new parts should be installed.

124. Differential

When repair involves disassembly of the differential and replacement of parts, refer to figure 81 and disassemble as follows:

a. Disassembly.

(1) Remove eleven bolts and nuts from differential housing flange and separate halves of housing.
(2) Remove safety wire and remove eight cap screws from spider housing; lift off housing and remove spider cross and gears.
(3) Remove side gear and oiling washer from beveled ring gear assembly; press off bearing cone.
(4) Press off bearing cone on spider housing and pull side gear from housing.
(5) Remove spider gear thrust washers and spider gears from cross.
(6) Remove six cap screws and washers from differential drive pinion adapter flange; remove snap ring from inside end of drive pinion shaft.
(7) Drive out drive pinion adapter flange and bearings as a unit.
(8) Press off bearings and remove adapter flange from drive pinion.

b. Reassembly. Reverse procedure for disassembly in *a* above, and refer to figure 81 for guidance and proper identification of components. Be sure that differential case runout does not exceed .002 inch; ring gear runout is less than .002 inch; and backlash between pinion and ring gear is .004–.008 inch.

125. Clutch

a. Disassembly. Refer to figure 82 and proceed as follows:

(1) Place the assembly on the bed of a press with a block under the pressure plate so arranged that the cover may be moved down.
(2) Place a block across the top of the cover, resting it on the spring bosses, and apply pressure to the assembly.
(3) Mark the cover and the pressure plate so that reassembly may be made in the same relative position.
(4) Remove screws from assembly and release spring pressure; remove cover.

b. Inspection.

(1) Examine all parts carefully and replace any doubtful components.
(2) Replace springs that have a pronounced blue or gray color or springs on which paint has been burned.
(3) Replace bent or twisted cover assembly.
(4) If the pressure plate is reground or replaced, do not re-use washers that may have been found between the clutch cover and the release lever yokes. However, the same washers must be re-used when-

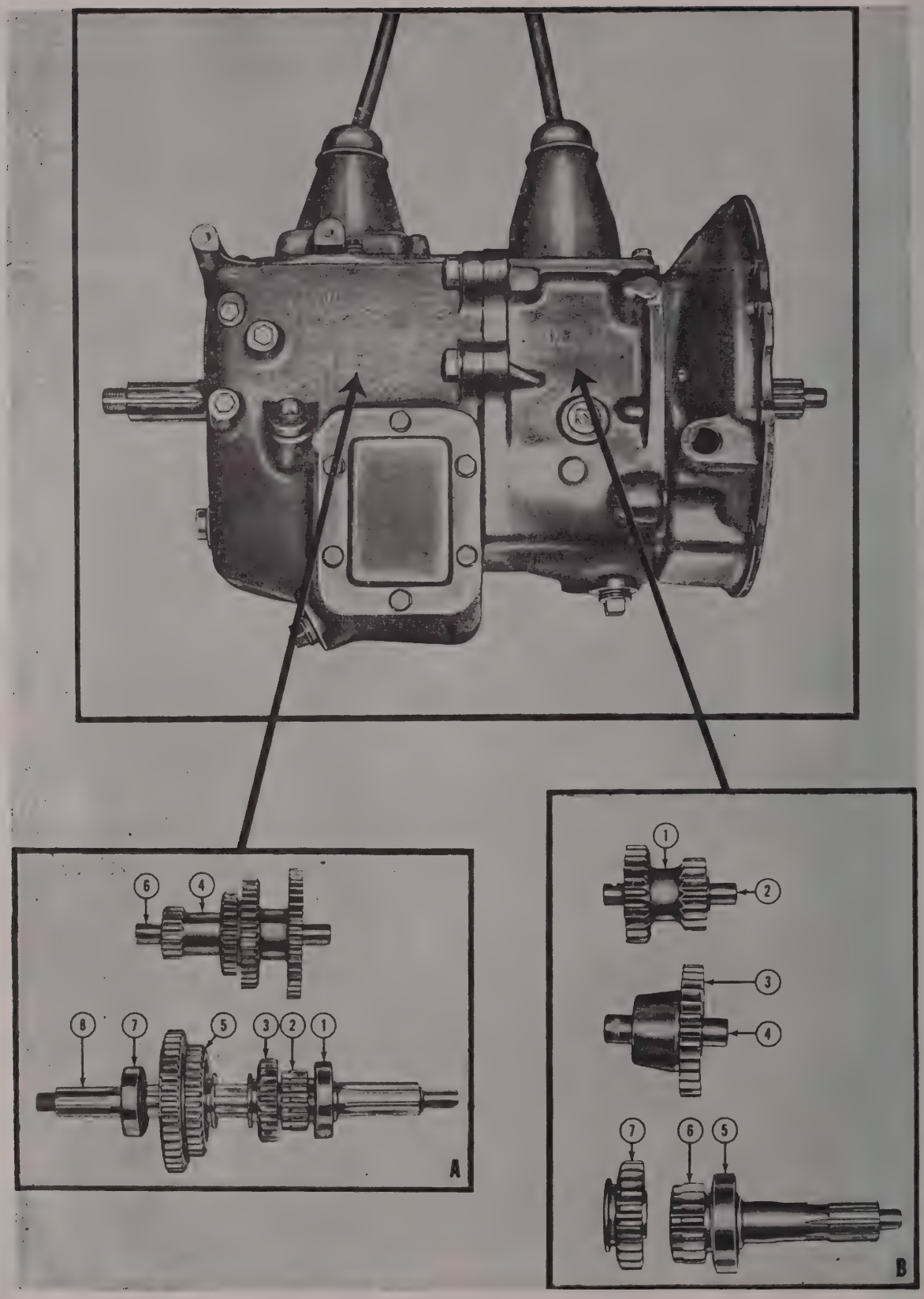


Figure 80. Reverse and main transmission shaft and gears.

A. Four-speed transmission

1 Input shaft bearing
2 Input shaft and main gear
3 Third and fourth speed sliding gear
4 Countershaft gear cluster
5 First and second speed selector gear cluster
6 Countershaft
7 Main output shaft bearing
8 Main output shaft

B. Forward-reverse transmission

1 Reverse idler gear cluster
2 Reverse idler gear shaft
3 Countershaft gear
4 Countershaft
5 Input shaft bearing
6 Input shaft and main gear
7 Sliding selector gear

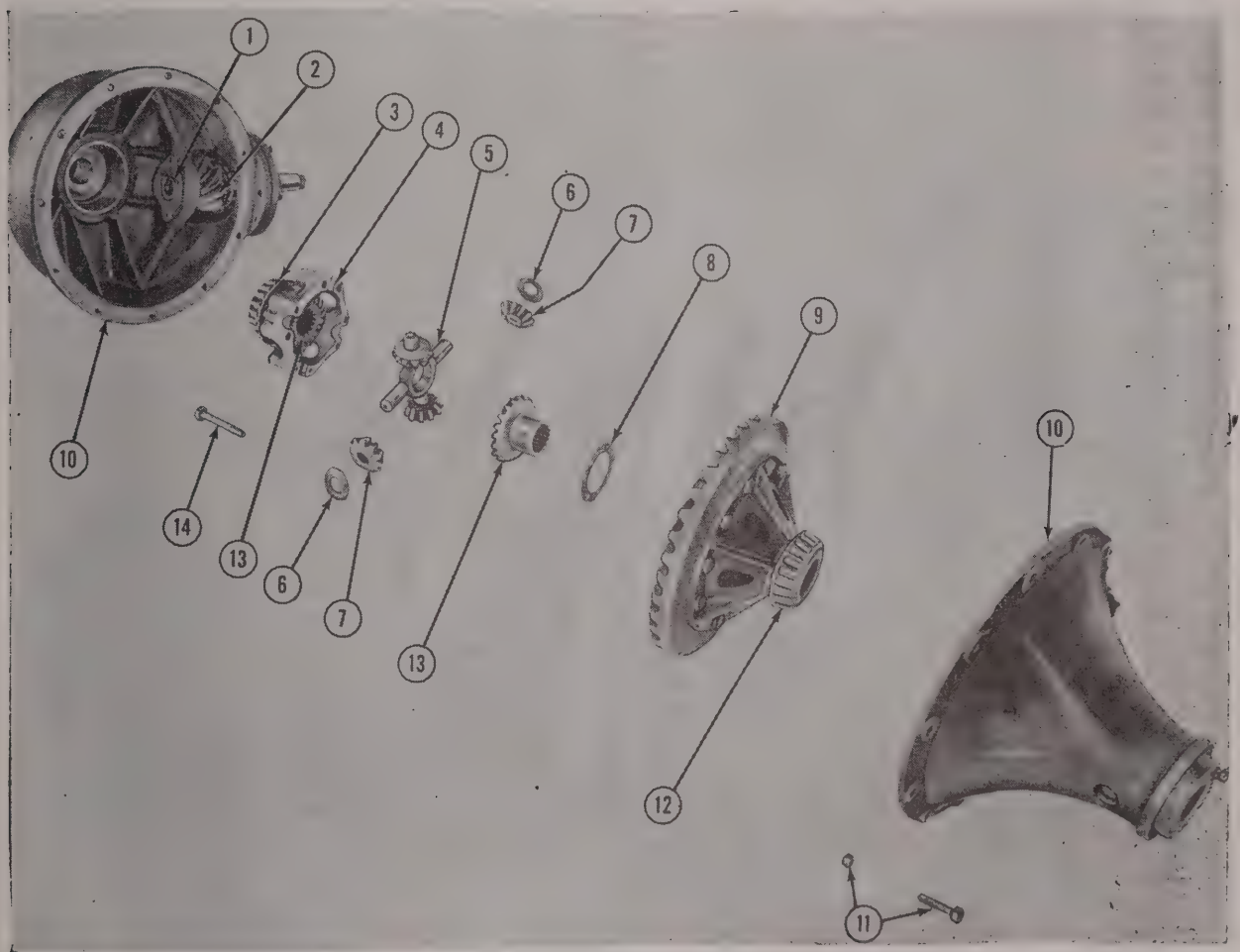
Figure 80—Continued

ever the pressure plate has not been altered during repair. If as much as .020-inch has been worn or ground from the face of the pressure plate, spacer washers .015-inch should be used between the cover and release yokes.

c. Major Adjustment.

(1) Use extra flywheel if available. If not available, remove flywheel from crane engine.

(2) Remove driven disk and replace with gage of thickness identical to that of disk. Mount the clutch assembly to the flywheel, turning the cover screws a turn at a time to prevent springing the cover. Be sure the gage is seated properly.



1 Drive pinion
2 Pinion shaft retaining snap ring
3 Bearing cone
4 Spider housing
5 Spider gear cross
6 Spider gear thrust washers
7 Spider gears
8 Oiling washer
9 Beveled ring gear assembly
10 Differential housing halves
11 Housing flange bolt and nut
12 Bearing cone
13 Side gears
14 Spider housing mounting cap screw

Figure 81. Differential—exploded view.

(3) Turn adjusting screws in ends of levers as far as they will go; back adjusting screws off until distance between ends of screws and face of flywheel is 2.062- to 2.125-inch. Check to see that heads of screws are within .005-inch of parallel.

(4) After the adjustment is correct on all levers, turn the pressure plate over and rest heads of adjusting screws on a metal surface. Using a staking chisel or a screw driver, peen a portion of each lever into slots of respective adjusting screws.

(5) If levers are not more than .030-inch out of parallel, no adjustment is necessary.

d. Reassembly.

(1) Mount the lever on the yoke; be sure the roller has been placed on the correct side of the flat-sided pin.

(2) Cut a pin from a steel rod of the same diameter as the lever pins and as long as the lever is wide. Use this pin as a guide to hold the needle bearings in position while the lever is being installed.

(3) After the lever has been installed, replace guide pin with permanent pin. Be sure that head of permanent pin is on drive side of lever before driving it through needle bearings to force out guide pin.

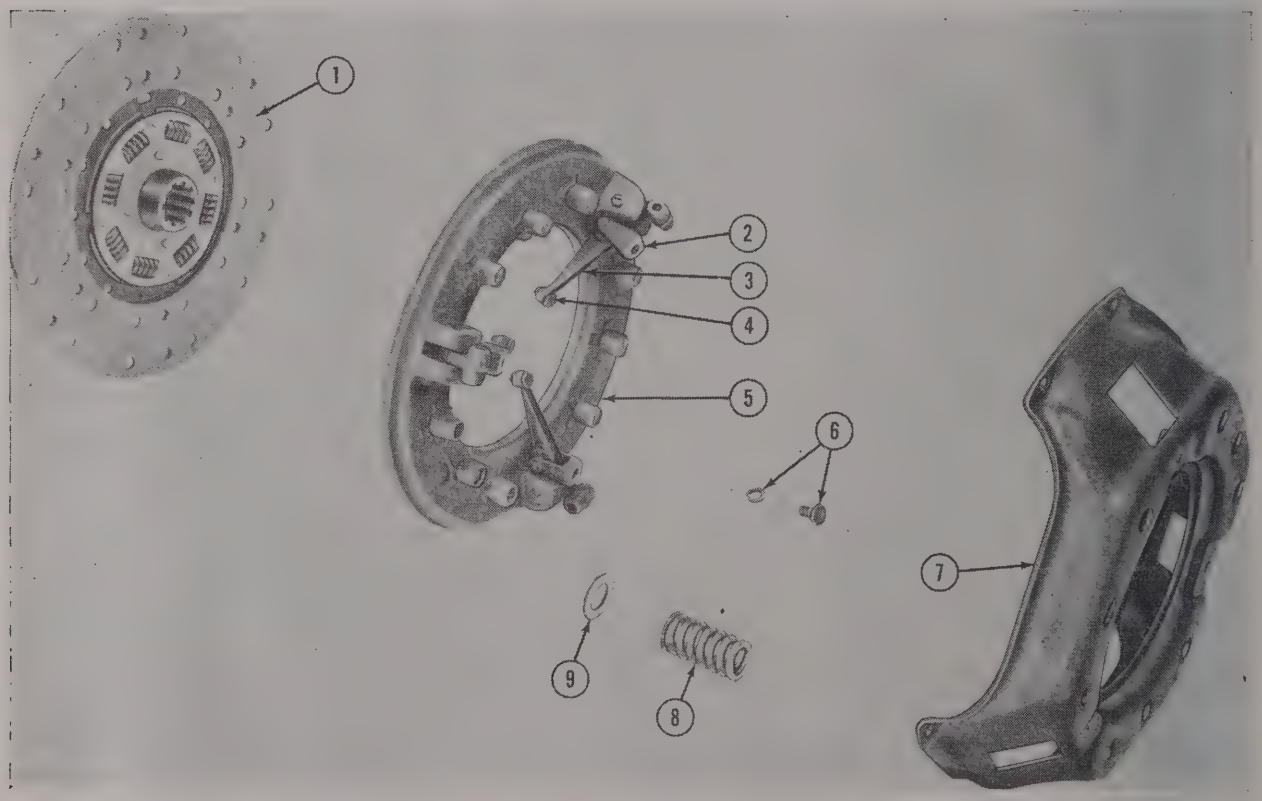
(4) Stake smooth end of pin to permit minimum lateral movement of .016-inch.

(5) Install lever adjusting screws and turn down all the way.

(6) Assemble pressure springs and locators; set yokes so that they are vertical to the pressure plate.

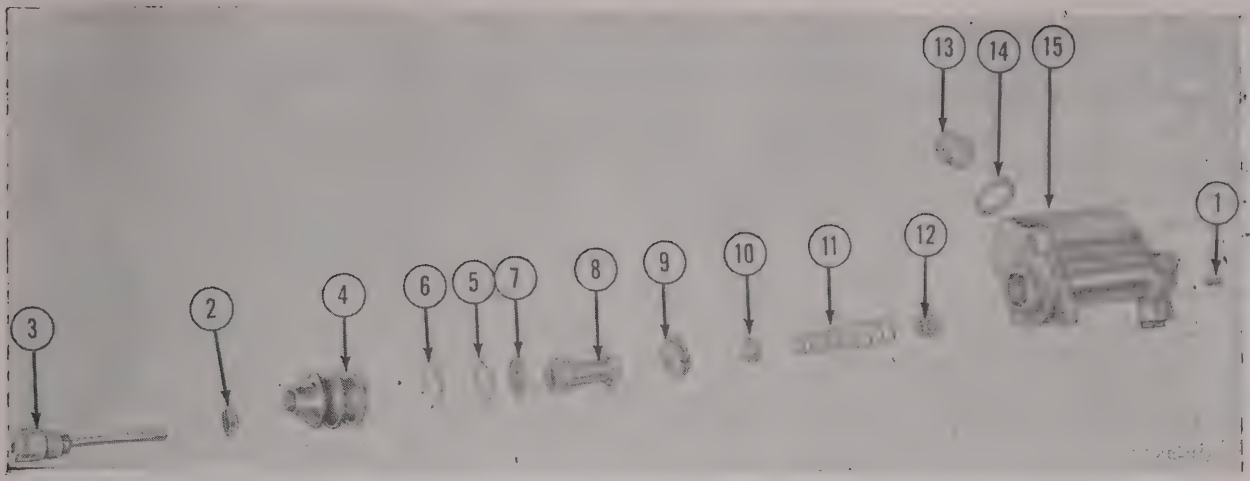
(7) Refer to marks made during disassembly and install the cover. Compress the cover slowly; guide the pressure plate lugs through holes in cover, making sure that the pressure springs are properly seated.

(8) Apply pressure to the levers, compressing and releasing the assembly several times, to see that all parts are properly positioned and correctly assembled.



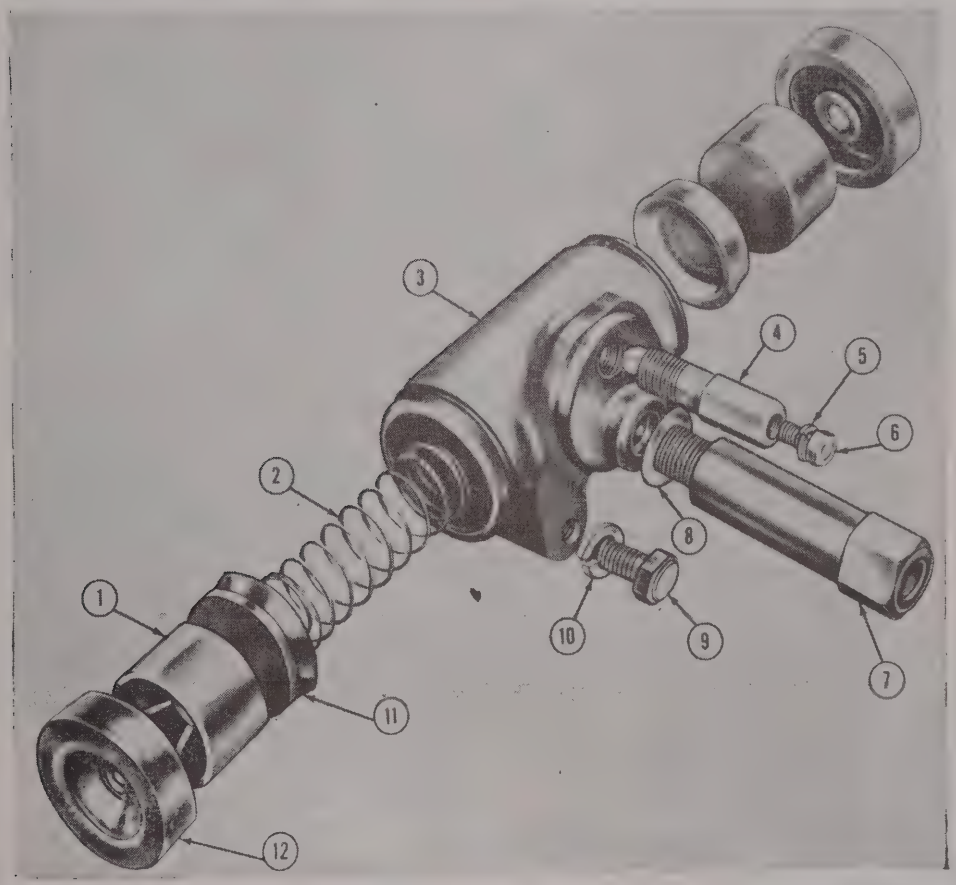
1 Driven disk
2 Release lever yoke
3 Release lever
4 Release lever adjusting screw
5 Pressure plate
6 Yoke fastening screw and lock washer
7 Cover plate
8 Pressure plate spring
9 Pressure plate spring washer

Figure 82. Clutch—exploded view.



1 Pipe plug
2 Small boot strap
3 Piston push rod
4 Boot and large boot strap
5 Piston secondary cup ring
6 Piston stop lockwire
7 Piston stop plate
8 Piston and cup protector assembly
9 Primary piston cup
10 Piston return spring retainer
11 Piston return spring
12 Check valve assembly
13 Filler plug
14 Filler plug gasket
15 Cylinder and tank casting assembly

Figure 83. Brake master cylinder—exploded view.



1 Piston assembly
2 Spring
3 Cylinder casting assembly
4 Bleeder screw
5 Lock washer
6 Screw
7 Adjusting cam and shoe guide stud
8 Cam stud washer
9 Wheel cylinder mounting screw
10 Lock washer
11 Piston cup
12 Boot

Figure 84. Brake wheel cylinder—exploded view.

126. Brake Master Cylinder

a. Disassembly. When repair involves disassembly of the brake master cylinder for inspection or replacement of parts, remove components in sequence as shown in figure 83.

b. Inspection.

(1) Make certain that port hole is open.

(2) Make certain that primary cup is smooth around outer edge. Remove burrs, if present.

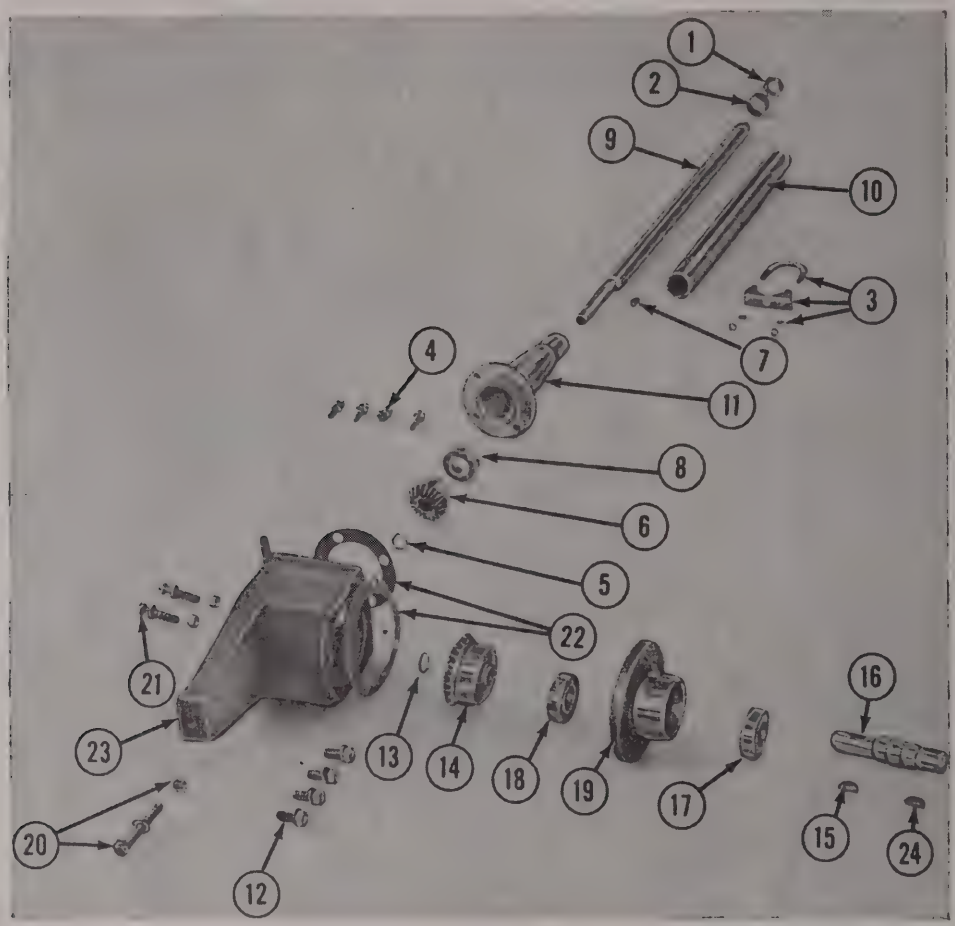
(3) Make certain that cylinder bore is smooth and not pitted or scratched. Rehone cylinder, if necessary.

(4) Replace oil-soaked cups and valves.

c. Reassembly. Reverse procedure as indicated in *a* above.

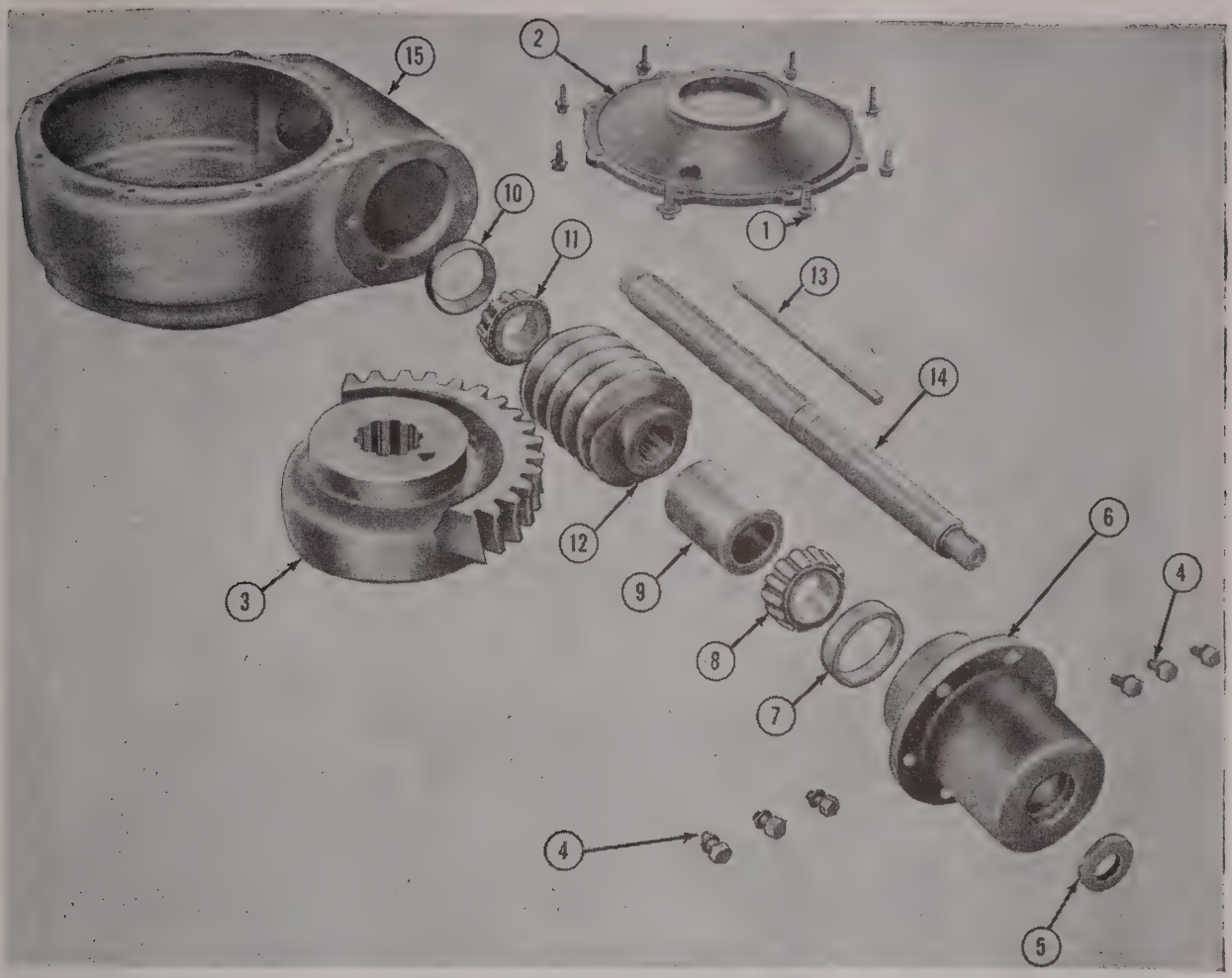
127. Brake Wheel Cylinder

When repair involves disassembly of the brake wheel cylinder, remove components in order of accessibility as shown in figure 84. Replace oil-soaked cups. Rehone cylinder bores, if necessary. Replace worn grease retainers.



1 Steering handwheel lock nut
2 Steering handwheel bearing
3 Steering column U-bolt and clamp
4 Steering column end cap mounting screws
5 Steering shaft pinion snap ring
6 Steering shaft pinion
7 Steering shaft key
8 Steering shaft lower bearing
9 Steering shaft
10 Steering column tube
11 Steering column end cap
12 Output shaft housing cap screws
13 Output shaft snap ring
14 Output shaft bevel gear
15 Output shaft key
16 Output shaft
17 Output shaft rear bearing
18 Output shaft front bearing
19 Output shaft housing
20 Steering gear case base mounting screw
21 Steering gear case upper mounting screws
22 Steering gear case gaskets
23 Steering gear case
24 Steering-output-shaft-to-intermediate-shaft key

Figure 85. Steering gear column and case—exploded view.



1 Gear case cover cap screws and washers
2 Gear case cover
3 Worm gear sector
4 Steering shaft end cover cap screws and washers
5 Steering shaft grease seal
6 Steering shaft end cover
7 Steering shaft bearing cup
8 Steering shaft bearing cone
9 Worm spacer
10 Worm drive shaft bearing cup
11 Worm drive shaft bearing cone
12 Worm
13 Worm key
14 Worm shaft
15 Worm and worm gear case

Figure 86. Worm and worm gear steering case—exploded view.

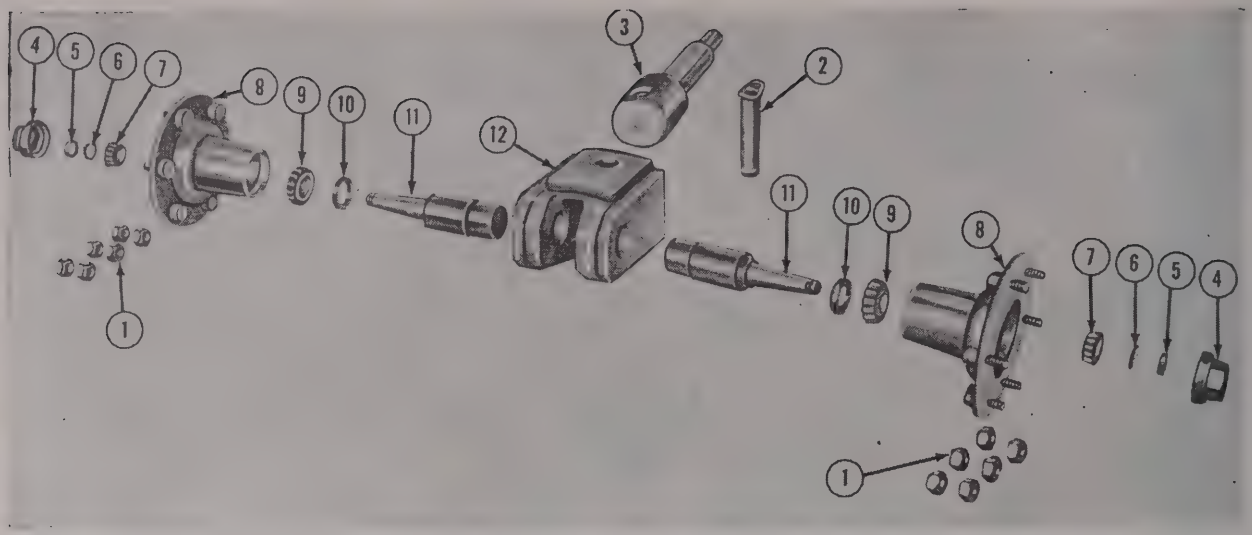
Section VII. STEERING SYSTEM

128. Steering Gear Column and Case

When repair involves the disassembly of the steering gear column and case, parts may be removed in order indicated in figure 85. The steering column end cap, steering shaft, drive pinion, and bearing may be removed as a unit. Remove steering shaft through top of end cap; be sure to place hand beneath end cap to catch bearing as it drops from end cap. The output shaft, driven gear, bearing, and housing may also be removed as a unit. Use a soft hammer to drive the output shaft and rear bearing through rear of housing.

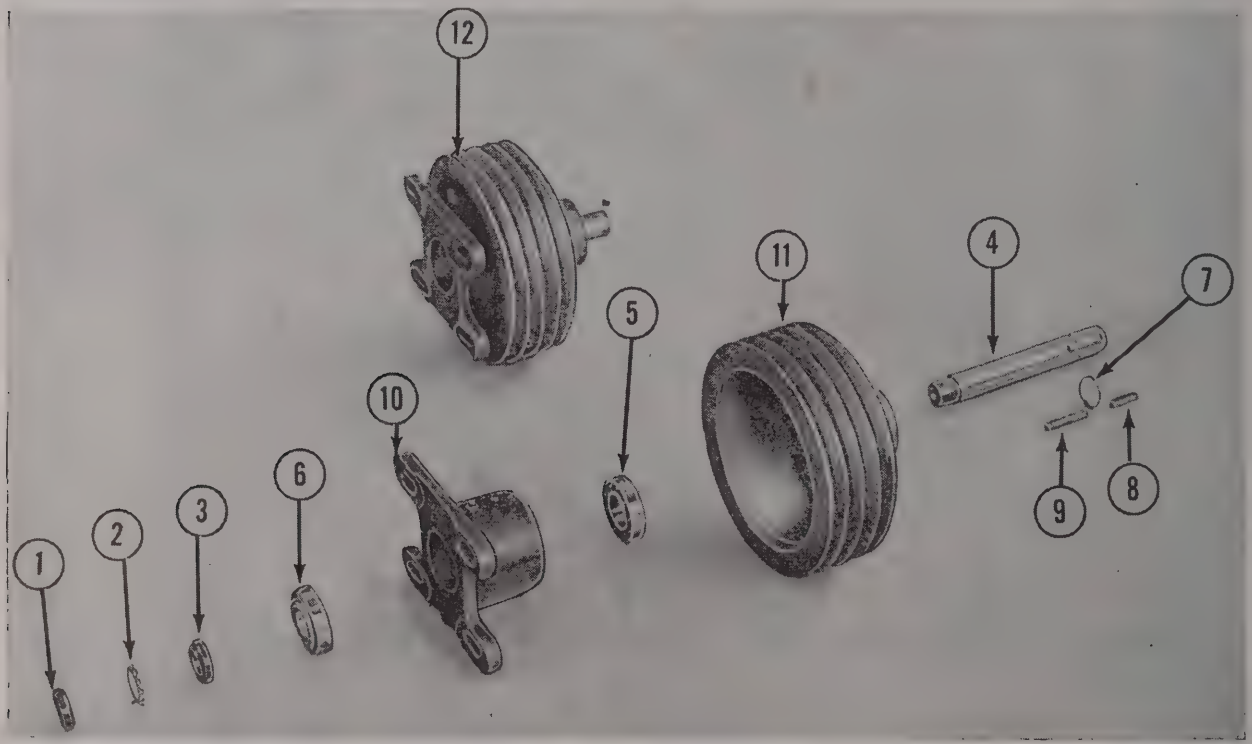
129. Worm and Worm Gear Steering Case

Refer to figure 86 for numerical sequence of disassembly when the worm and worm gear steering case assembly is in need of repair or parts are to be replaced. Take care not to damage teeth of worm gear sector during disassembly or reassembly.



1 Wheel nuts
2 Rocker pin
3 Vertical spindle
4 Hub grease cap
5 Wheel bearing lock nut
6 Wheel bearing lock washer
7 Outer bearing cone
8 Wheel hub
9 Inner bearing cone
10 Wheel bearing seal
11 Stub axle
12 Saddle box

Figure 87. Steering axle—exploded view.



1 Lock nut
2 Externally grooved lock washer
3 Lock nut
4 Pulley shaft
5 Bearing
6 Bearing
7 Snap ring
8 Key, winch drive shaft
9 Key, pulley
10 Pulley mounting bracket
11 Side power take-off pulley
12 Side power take-off pulley assembly

Figure 88. Side power take-off pulley—exploded view.

130. Steering Axle

The numerical order of disassembly when the steering axle is to be repaired or parts are to be replaced is indicated in figure 87. Do not attempt to remove stub axles from saddle box. Be sure all moving parts are properly lubricated before reassembly.

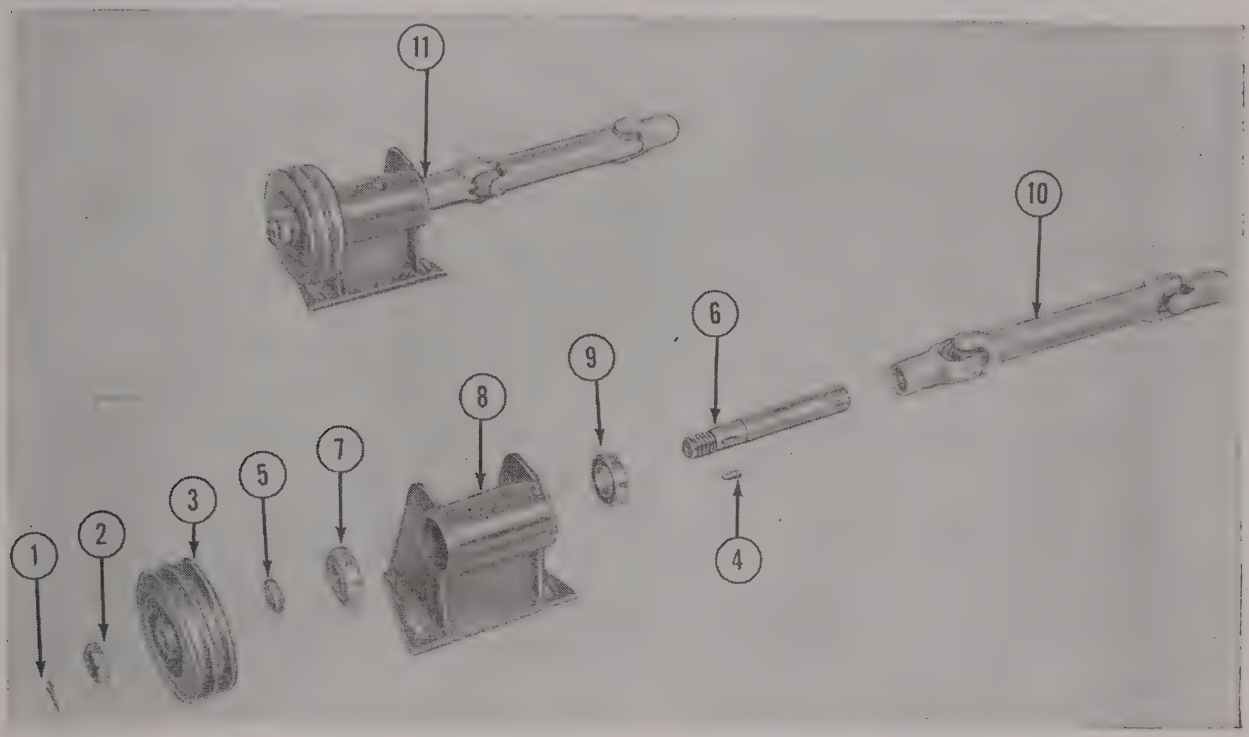
Section VIII. POWER TAKE-OFFS

131. Side Power Take-Offs

The side power take-offs are identical for both the load hoist and boom topping winches. When repair or part replacement makes necessary the disassembly of these units, refer to figure 88 and disassemble in sequence indicated.

132. Sluing Power Take-Off

If the sluing clutch power take-off must be disassembled for inspection or repair, refer to figure 89 and remove parts in sequence indicated.



1 Cotter key
2 Lock nut
3 Sluing take-off drive pulley
4 Sluing take-off drive pulley key
5 Lock nut
6 Sluing take-off pulley drive shaft
7 Sluing take-off pulley drive shaft bearing
8 Sluing power take-off assembly mounting bracket
9 Sluing take-off pulley drive shaft bearing
10 Sluing take-off propeller shaft
11 Sluing drive power take-off assembly, assembled

Figure 89. Sluing drive power take-off assembly—exploded view.

Section IX. SLUING MECHANISM

133. Sluing Clutch and Transmission

When repair or inspection requires disassembly of the sluing clutch and transmission, refer to figure 90 and remove parts in sequence indicated. Tap out bearings and oil seals with a soft hammer and press out bevel pin from adapter flange bearing.

134. Sluing Clutch Major Adjustment

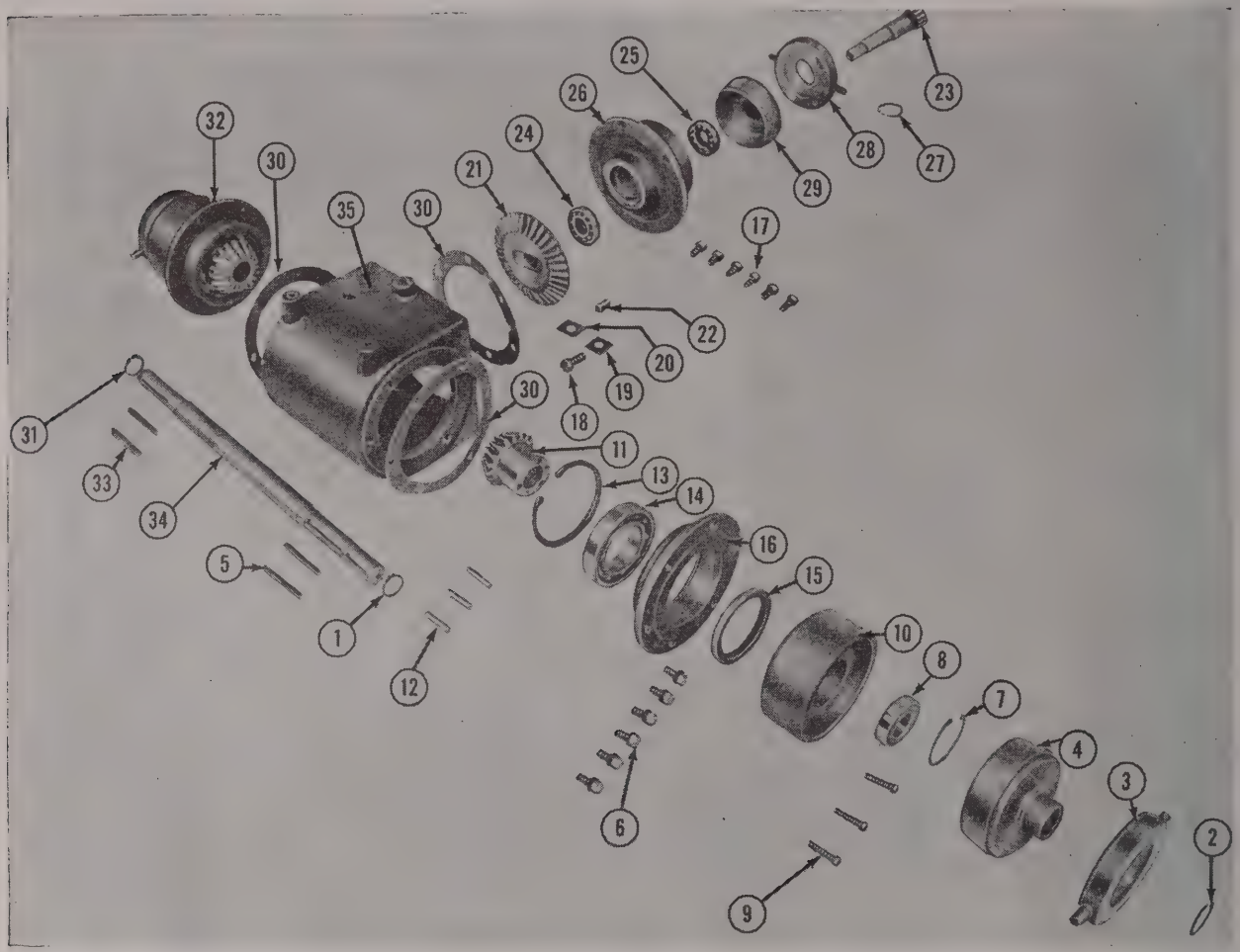
a. Remove linkage from clutch lever.
b. Disconnect boom sluing stop.
c. Loosen brake adjustment screw.
d. Remove cotter key and pin from brake toggle.
e. Turn sluing shifter shaft clockwise to tighten clutch; adjust by rotating one-half turn and check by replacing linkage and shifting lever arm.

f. When clearance of 1/8 to 3/16 inch has been obtained, replace toggle pin and key.

g. Connect boom sluing stop, and check to see that all cotter keys are in place.

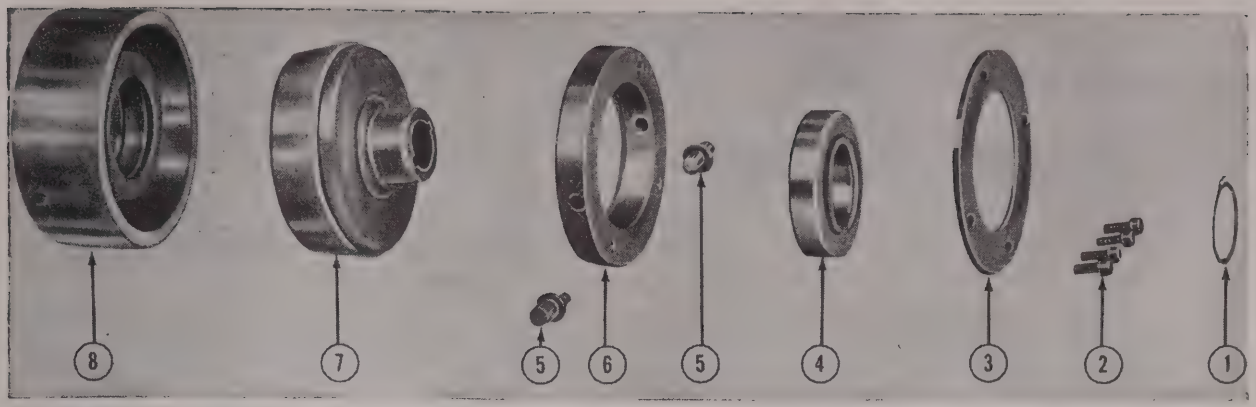
135. Sluing Brake

When the sluing brake is to be inspected or repaired, refer to figure 91 and remove the parts in numerical sequence.



1 Clutch locating snap ring
2 Clutch throwout bearing snap ring
3 Right hand clutch throwout bearing
4 Right hand clutch driving half
5 Clutch driving keys
6 Clutch end cap cap screws
7 Input shaft bearing snap ring
8 Input shaft bearing
9 Clutch and gear cap screws
10 Right hand clutch driven half
11 Right hand clutch drive pinion
12 Clutch and gear dowel pins
13 End cap bearing retainer snap ring
14 Right hand clutch end cap bearing
15 Right hand clutch end cap oil seal
16 Right hand clutch end cap
17 Sluing brake cone clutch stationary half cap screws
18 Bevel gear keeper plate cap screw
19 Bevel gear keeper plate
20 Bevel gear lock plate
21 Sluing output bevel gear
22 Sluing output bevel gear key
23 Output shaft and sprocket
24 Output shaft inner bearing
25 Output shaft outer bearing
26 Brake cone clutch stationary half
27 Sluing brake throwout bearing retainer snap ring
28 Sluing brake throwout bearing
29 Sluing brake cone clutch driven half
30 Transmission housing gaskets
31 Left hand clutch locating snap ring
32 Left hand clutch assembly
33 Clutch driving keys
34 Sluing input shaft
35 Sluing transmission case

Figure 90. Sluing transmission and brake assemblies—exploded view.



1 Bearing retainer snap ring
2 Brake throwout bearing cap cap screws
3 Brake throwout bearing cap
4 Brake throwout bearing
5 Brake throwout bearing collar pins
6 Brake throwout bearing collar
7 Brake cone clutch driven half
8 Brake cone clutch stationary half

Figure 91. Sluing brake and throwout bearing assembly—exploded view.

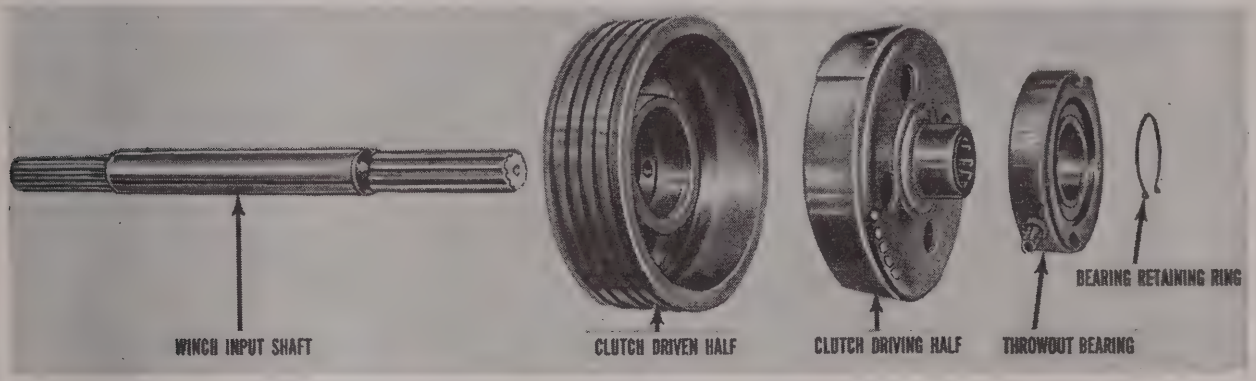
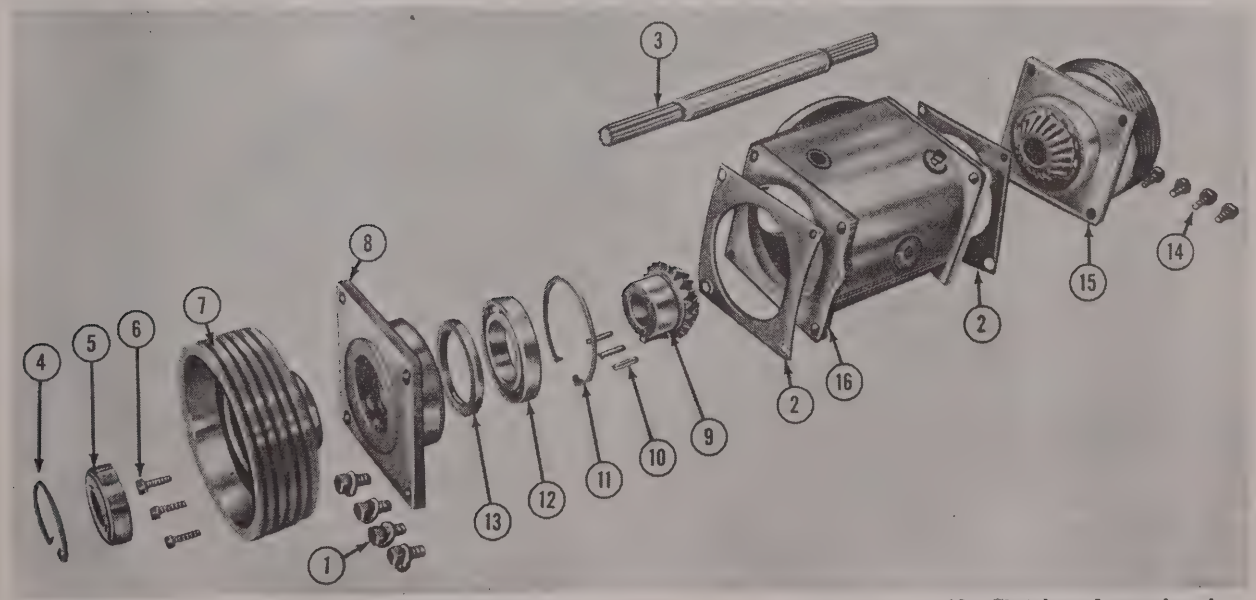


Figure 92. Load hoist and boom topping clutches—exploded view.



1 End cap cap screws
2 Gaskets
3 Input shaft
4 Input shaft bearing retaining snap ring
5 Input shaft bearing
6 Clutch and gear cap screws
7 Clutch driven half
8 Input shaft end cap
9 Transmission bevel drive gear
10 Clutch and gear dowel drive pins
11 Clutch and gear bearing retaining snap ring
12 Clutch and gear bearing
13 Input shaft end cap seal
14 End cap cap screws
15 Clutch and gear assembly
16 Housing

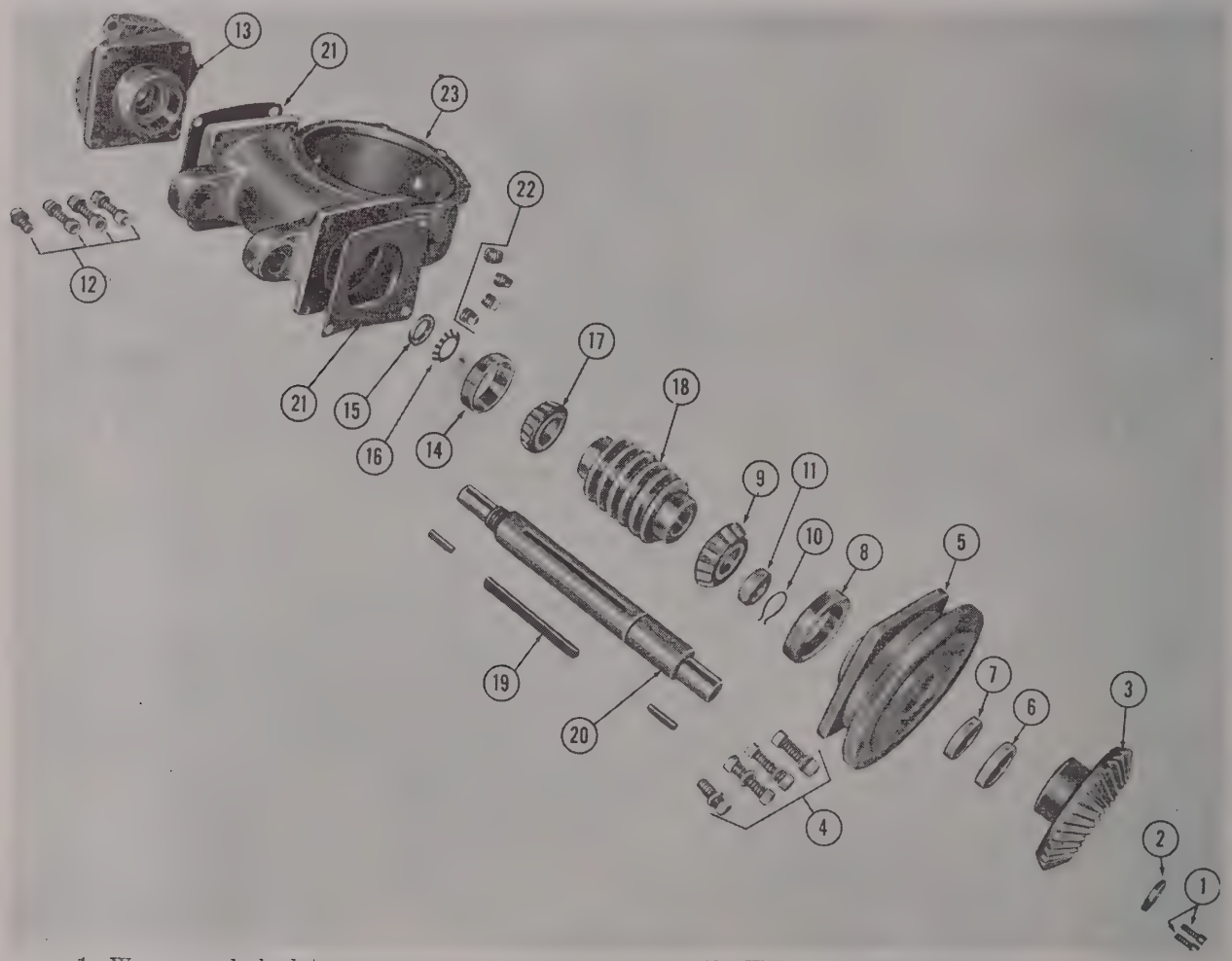
Figure 93. Load hoist and boom topping transmissions—exploded view.

136. Load Hoist and Boom Topping Clutches

The load hoist and boom topping clutches are identical in construction. When repair requires the disassembly of either or both clutches, refer to figure 92 and remove parts according to indicated sequence. Remove load line that lowers the clutch driving section from one end of the input shaft and the load line raising clutch driving section from the other end of the input shaft in consecutive steps. Driven sections and bearing assemblies may be removed as a unit with a gear puller. Transmission bevel drive pinion must be removed from the input shaft adapter flange with an arbor press. The ball cages are riveted to the drive pinion bearings and disassembly should not be attempted.

137. Load Hoist and Boom Topping Transmissions

When it is necessary to disassemble the load hoist or boom topping transmissions to effect repair or replacement of parts, refer to figure 93 and remove parts in numerical order.



1 Worm gear lock plate cap screws
2 Worm gear lock plate
3 Worm gear
4 Worm shaft adapter nuts, bolts, and cap screw
5 Worm shaft adapter
6 Lower adapter seal
7 Top adapter seal
8 Lower bearing cup
9 Worm shaft lower bearing cone
10 Snap ring
11 Snap ring collar
12 Winch brake housing mounting bolts and cap screw
13 Winch brake housing
14 Worm shaft upper bearing cup
15 Worm shaft upper bearing lock nut
16 Worm shaft upper bearing lock washer
17 Worm shaft upper bearing cone
18 Winch worm
19 Winch worm key
20 Winch worm shaft
21 Gaskets
22 Winch worm and worm gear case plugs
23 Winch worm and worm gear case

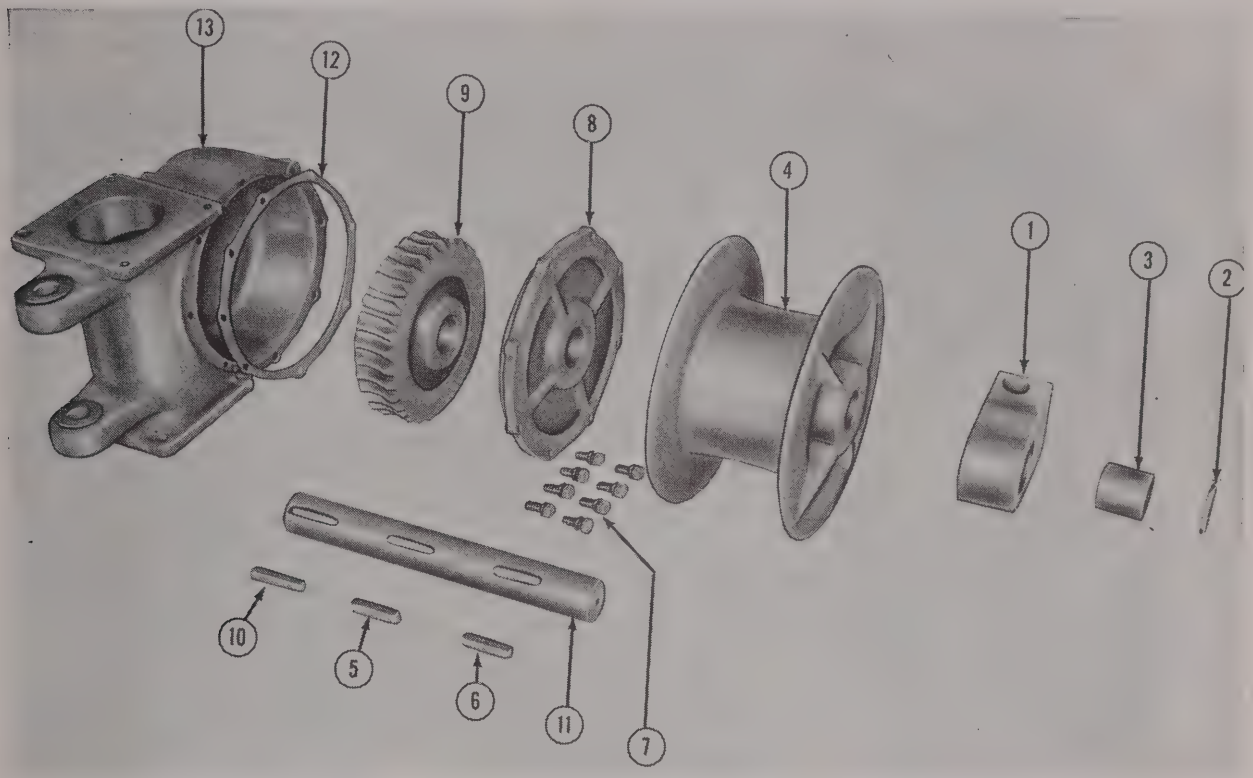
Figure 94. Load hoist and boom topping winch worm and worm gear assembly—exploded view.

138. Load Hoist and Boom Topping Winches

The identical load hoist and boom topping winches consist of the units shown in numerical order of disassembly below (figs. 94 and 95). When removing parts of the winch worm and worm gear assembly, use a soft drift to tap out the outboard bearing end cap and bushing. Use a gear puller to press worm gear off winch drum shaft. Use a soft drift to drive off driven bevel gear from worm shaft.

139. Winch Brakes

The winch brakes, which are the same on both winches, may be disassembled for repair or inspection in accordance with numerical sequence indicated in figure 96. Use a soft drift and tap lightly when removing oil seals.



1 Winch outboard bearing
2 Winch drum shaft dust cover
3 Winch outboard bearing bushing
4 Winch drum
5 Winch drum key
6 Winch drum key
7 Winch worm gear case side plate cap screws and washers
8 Winch worm gear case side plate
9 Winch worm gear
10 Winch worm gear key
11 Winch drum shaft
12 Gasket
13 Winch worm and worm gear case

Figure 95. Load hoist and boom topping winch worm and worm gear drive assembly—exploded view.

Section XI. MAST AND TURNTABLE ASSEMBLY AND BOOM

140. Mast and Turntable Assembly

a. Disassembly. The mast and turntable assembly (fig. 97) may be disassembled as follows when repair or inspection is involved:

(1) Remove instrument panel.
(2) Remove four nuts from U-bolts that secure mast to mast support bracket and remove U-bolts.
(3) Remove sheave head bearing halves.
(4) Remove nine machine screws and washers and remove dust seal.
(5) Remove 16 cap screws securing sluing table cover to top plate.
(6) Remove two lubrication fitting extensions at each side of rear end of cover plate.
(7) Attach hoist lines and lift off turntable assembly; place on suitable workbench.

(8) Remove bearing and cup from later models, using a drift which may be inserted in holes provided for this purpose in the mast pipe base and the turntable plate, respectively.

(9) Remove cap screw from sheave head pin; remove snap ring from opposite side of pin.

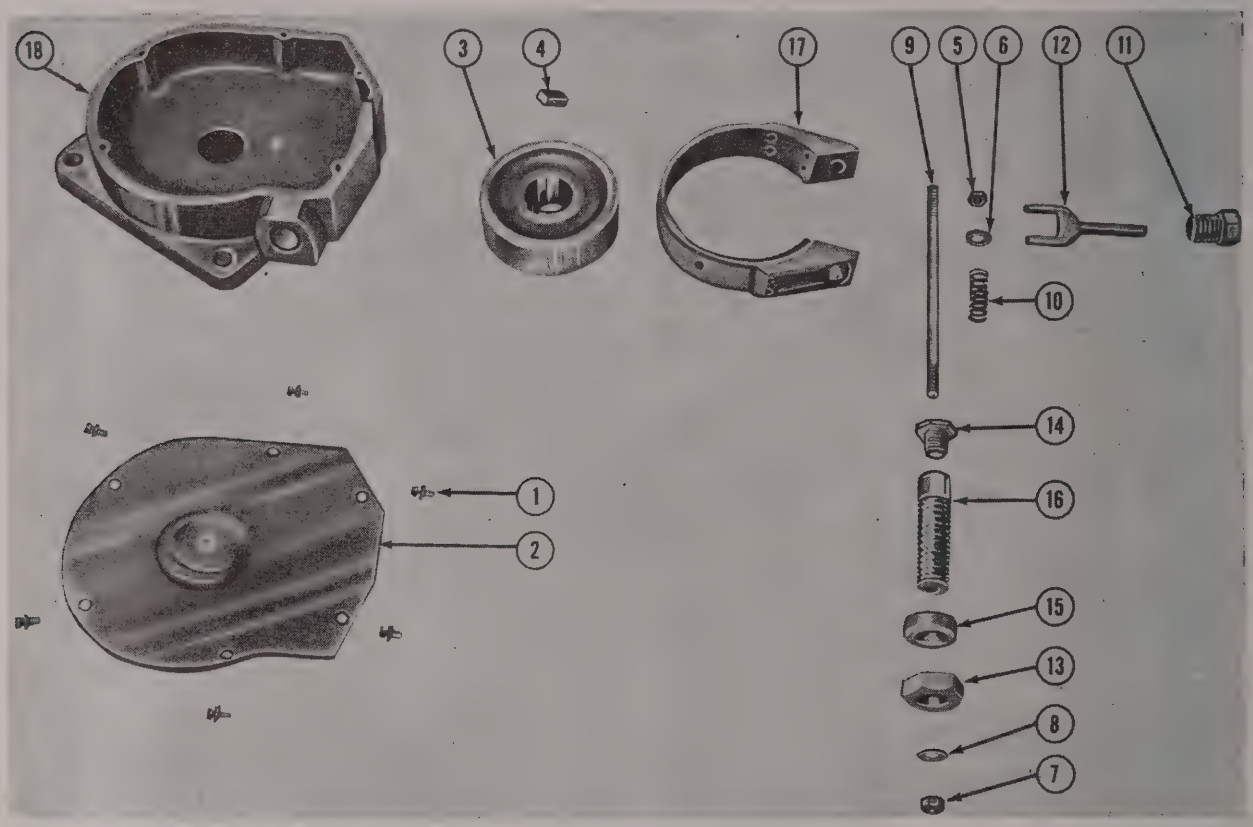
(10) Remove sheave head pin lubrication fitting and drive pin from head; remove all parts from mast sheave head.

(11) Remove four cap screws that secure sheave head cable safety shield to boom topping dead-end yoke.

(12) Remove cotter pin and drive out mast load line sheave pin.

(13) Remove six cap screws and remove sluing worm gear sector.

(14) Remove three cap screws at either end of the sluing worm shaft connecting sluing shaft support brackets to top plate.



1	Housing cover cap screws	7	Spring rod lock nut	13	Brake band positioning lock nut
2	Housing cover	8	Spring rod lock washer	14	Brake band keeper
3	Brake drum	9	Brake spring rod	15	Brake band positioning nut
4	Brake drum key	10	Brake spring rod spring	16	Brake band positioning rod
5	Spring rod lock nut	11	Brake throwout yoke collar	17	Brake band
6	Spring rod lock washer	12	Brake throwout yoke	18	Brake housing

Figure 96. Winch brake assembly—exploded view.

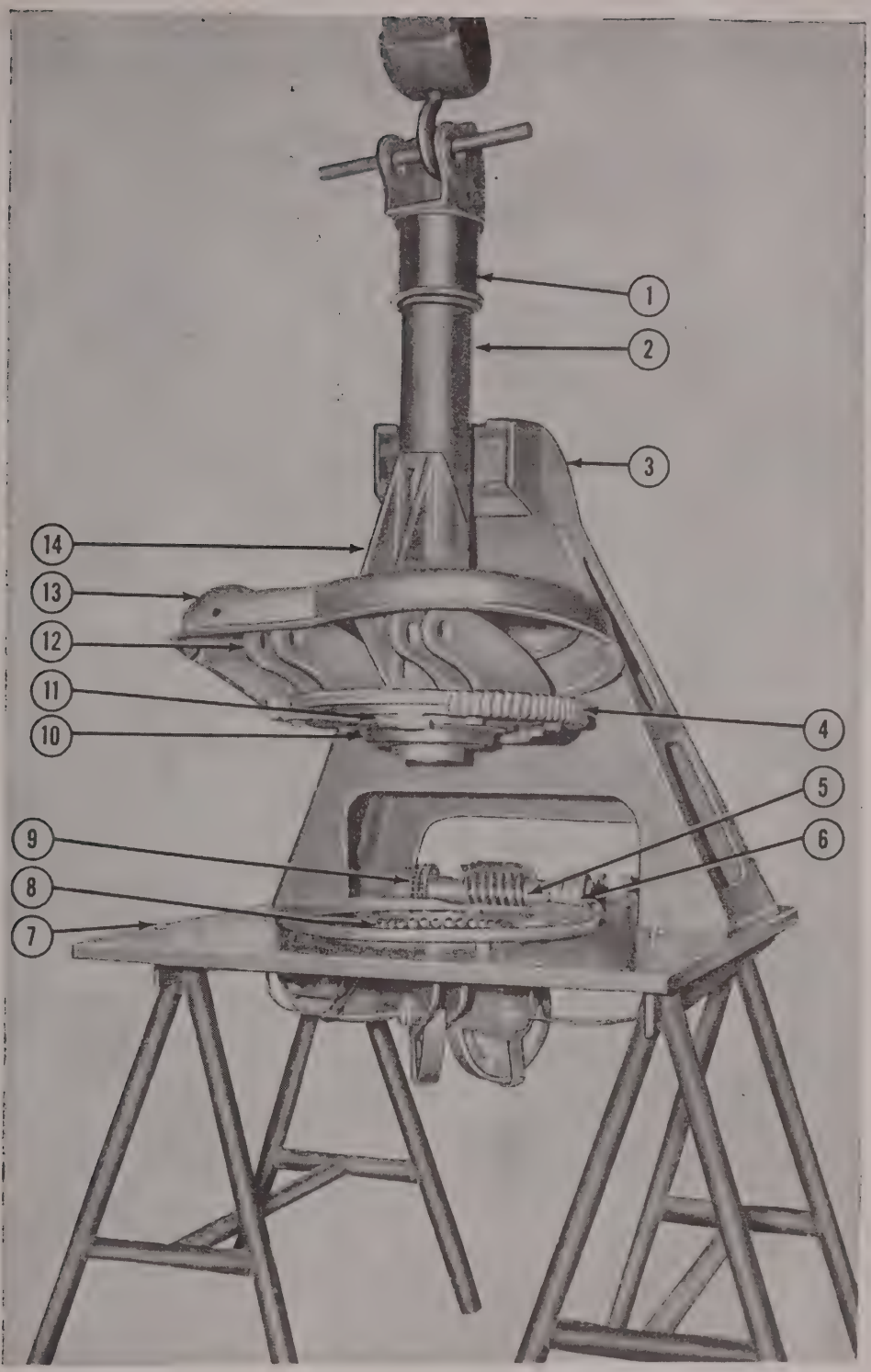
(15) Remove cotter pin from sluing chain and drive out pin from link; remove chain.

b. Reassembly. Reverse procedure in *a* above.

141. Boom

a. Disassembly. The boom may be disassembled while it is still attached to the crane, or may be removed from the crane and placed on blocks so that it is supported at both ends and beneath the front end of the lower section. In either case the boom head must be supported by sufficient blocking to raise it to the same level as that of the base of the lower boom section.

(1) Remove cotter keys from locking pins in lower and upper sections of boom and drive out pins.



1 Mast sheave head
2 Mast pipe
3 Mast support bracket
4 Sluing worm gear
5 Sluing worm
6 Sluing worm shaft bearing support
7 Top plate front section
8 Lower ball race
9 Sluing worm shaft pinion and chain
10 Upper ball race
11 Sluing safety stop
12 Boom heel mounts
13 Sluing table cover
14 Load line sheave bracket

Figure 97. Mast and turntable assembly—exploded view.

(2) Remove cables.
(3) Rack out the upper section and use a hoist to swing it free of the lower section.
(4) Do not attempt to disassemble the boom pinion gear and shaft assembly as it is a welded unit and should not be disassembled.
(5) Remove cotter key; drive out pin; and remove end sheave from boom head.
(6) Remove cotter key and drive out cable dead-end pin.
(7) Remove cotter key and drive out load line guide sheave.
(8) Remove cotter key and drive out the pin on which are mounted the three boom topping cable sheaves.
(9) Remove two nuts and bolts from boom pinion gear and shaft assembly mounting brackets and remove assembly.

b. Reassembly. Reverse procedure in *a* above and fit boom to desired length, making sure that boom pinion gear is fully engaged with boom rack.

CHAPTER 6

SHIPMENT, LIMITED STORAGE, AND DEMOLITION

142. Domestic Shipment and Storage

The following instructions apply to a crane that is ready for immediate use upon arrival but that will be out of service for a period of less than 30 days. If the crane is to be indefinitely stored after shipment by rail, it will be prepared for such storage at its destination.

a. Lubrication. Lubricate crane completely, following instructions on Lubrication Orders 10–1692A–1 and 10–1692A–2.

b. Cooling System. Add proper quantity of antifreeze compound if freezing temperatures are expected during the period of shipment or storage. Inspect entire cooling system for leakages.

c. Tires. Clean all tires thoroughly. Do not store crane on floors, cylinders, or other surfaces soaked with grease or oil. Wash off immediately any oil, grease, or gasoline that appears on tires.

d. Operation Test. Put crane through an operation test similar to but less extensive than the run-in test to be sure it performs satisfactorily. Correct all deficiencies if equipment is available for such services. If repairs cannot be made at this time, make appropriate notations on a tag and attach tag to steering wheel. The tag may also have noted thereon an appraisal of the general condition of the crane.

e. Fuel Tank. It is not necessary to drain the fuel from the tank for shipment or storage within the continental United States except when the crane is to be stored in locations where fire ordinances or local regulations require removal of gasoline before storage.

f. Body. Remove rust that appears on any part of exterior. Paint wherever necessary to protect against deterioration. Apply medium grade protective lubricating oil to exposed polished or ground metal surfaces that are susceptible to rust.

g. Engine. To prepare the engine for storage:

(1) Remove air cleaner extension tube from carburetor.

(2) Start engine and set throttle to run engine at fast idle.

(3) Pour 1 pint of medium grade preservative lubricating oil into carburetor, being careful not to choke engine.

(4) Turn off ignition switch as quickly as possible after oil has been poured into carburetor.

(5) Open throttle wide and turn engine over five complete revolutions by hand and with the switch off.

(6) Install air cleaner extension tube on carburetor.

h. Crane Components. All cables, the boom, the winches, and the sluing drive chain and sprocket should be coated with engine oil (OE)—used, if available.

i. Inspection. Make a systematic inspection just before shipment or storage to make sure that all required steps have been taken and that the crane is mechanically ready for operation on call. Cranes in limited storage will be inspected every 48 hours. Batteries that require water or recharging will be serviced at these times. Do not attempt to charge battery by running engine. Charge battery with a portable charger or remove battery for charging.

143. Oversea Shipment

To insure safe transit and to protect the crane against weather, shipping personnel should adhere to the principles set forth in United States Military specification 162.

144. Loading and Blocking for Rail Shipment

In addition to the preparations prescribed in preceding paragraphs, the following precautions will be taken when quartermaster cranes are prepared for rail shipment:

a. Exterior. Place a tarpaulin or other canvas cover over the crane for shipment on an open car.

b. Battery. Disconnect the ground cable from the battery and tape the terminal end to prevent the battery from being discharged by accident. A note on the steering handwheel tag should advise the receiver that the ground cable has been disconnected.

c. Brakes. Apply brakes and place transmission in low gear after the crane has been properly positioned on the flatcar. Set hand brakes and wire down foot brake pedal.

d. Loading. Load and unload crane under its own power, whenever possible, using permanent ramps or spanning platforms.

e. Securing Crane. The crane may be secured to the flatcar by the following method:

(1) Spike blocks on the car floor, one at the front and one at the end of each crane wheel.

(2) Place two cleats, each the approximate length of wheel diameter (with tire mounted) against outside face of each wheel.

(3) Spike lower cleat to car floor and the top cleat to the one below.

(4) Pass at least four strands of strong wire around the steering axle at rear of crane and around drive axle at front of crane and through the stake pocket on the flatcar. Tighten wires at both ends of crane and draw snug with a bar or stick. Blocking and cleating will usually suffice to secure crane in a closed car.

145. Demolition

The crane must be demolished only to prevent its capture and use by the enemy. Care must be taken to destroy the same parts on all cranes to prevent enemy use through cannibalization.

146. Detailed Instructions

a. Engine. Place a heavy pointed steel bar against cylinder block and beside distributor. Drive bar through block and into crankcase and camshaft, using a heavy hammer.

b. Driving Axle. Place a heavy pointed steel bar against differential case and drive bar through case and into differential gears.

c. Transmission and Clutch. Smash transmission cases, using a heavy hammer or sledge.

d. Carburetor and Manifold. Smash these assemblies.

e. Generator, Ignition Coil, Distributor, and Spark Plugs. Smash these assemblies.

f. Battery. Break case and plates.

g. Radiator. Drive large holes through core and tubes.

h. Fuel Tank. Drive a large hole through tank.

i. Boom Topping, Load Hoist, and Sluing Transmissions. Place a heavy pointed steel bar against gear cases and drive bar through into gears with heavy hammer or sledge.

APPENDIX I

REFERENCES

1. Indexes

SR 310–20–4	Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, Modification Work Orders, Tables of Organization and Equipment, Tables of Allowances, Tables of Organization, and Tables of Equipment.
SR 310–20–5	Index of Administrative Publications.

2. Maintenance

TB 37–2810–1	Second-Echelon Maintenance Services and Technical Inspections of Materials Handling Equipment.
TM 9–2855	Instruction Guide: Operation and Maintenance of Ordnance Materiel in Extreme Cold (0° to −65° F.).
TM 37–2810	Motor Vehicle Inspection and Preventive Maintenance Services.
MWO 10–1619–1	Installation of Hour Meter on Powered Materials Handling Equipment.

3. Miscellaneous

SR 700–10–30	Registration of Materials Handling Equipment.
AR 850–20	Precautions in Handling Gasoline.
FM 21–5	Military Training.
FM 21–8	Military Training Aids.
SR 310–90–1	Distribution and Supply of Publications and Blank Forms.
TM 9–2852	Instruction Guide, Welding Theory and Application.

4. Nomenclature

SR 320–5–1	Dictionary of United States Army Terms.
SR 320–50–1	Authorized Abbreviations.

5. Operational

TM 21–302	Operator Selection and Training: Materials Handling Equipment.

APPENDIX II

TABLE OF COMPONENTS

- Air cleaner:
  - Make: Industrial Wire Cloth Products
  - Model: A–12760
  - Type: Oil bath
- Axles:
  - Driving:
    - Make: Hughes-Keenan
    - Model: 10013–B
    - Type: Stub integral
  - Steering:
    - Make: Hughes-Keenan
    - Model: 10042
    - Type: Vertical spindle
- Battery:
  - Make: Auto-Lite
  - Model: 2HR–12OR
  - Type: Storage
- Brake master cylinder:
  - Make: Wagner
  - Model: FE–3572
  - Type: Hydraulic
- Brakes:
  - Hand:
    - Make (brake lever): Orscheln
    - Model: 1500–C4–180X
    - Type: Mechanical
  - Service:
    - Make: Wagner
    - Model: FF–3428 and FF–3429
    - Type: Internal expanding, hydraulic
- Carburetor:
  - Make: Ford
  - Model: 1602
  - Type: Downdraft
- Clutches:
  - Engine:
    - Make: Long Manufacturing Division (Borg-Warner)
    - Model: 10137
    - Type: Single-plate, dry-disk
  - Boom topping and load hoist:
    - Make: Hughes-Keenan
    - Model: 10105 (driving member); 10107 (driven member)
    - Type: Friction-cone, 8-inch
  - Sluing:
    - Make: Hughes-Keenan
    - Model: 10065–2B (driving member); 10065–4 (driven member)
    - Type: Friction-cone, 5-inch
- Distributor:
  - Make: Ford
  - Model: 7HA–12127
- Distributor—Continued
  - Type: Vacuum advance
- Engine:
  - Make: Ford
  - Model: H–226
  - Type: 6-cylinder, L-head
- Fuel pump:
  - Make: Ford
  - Model: 1638
  - Type: Vacuum
- Generator:
  - Make: Ford
  - Model: 8HT–10000–A
  - Type: 2-rush, shunt-wound
- Governor:
  - Make: King-Seeley
  - Model: V5S–226D–C4
  - Type: Vari-speed (velocity)
- Ignition coil:
  - Make: Ford
  - Model: 8HA–12290
- Starting motor:
  - Make: Ford
  - Model: 8HA–1101
  - Type: Bendix drive
- Steering gear:
  - Make: Hughes-Keenan
  - Model: 10048
  - Type: worm and gear
- Tires:
  - Drive wheel:
    - Make: Firestone
    - Model: 9.00 x 20, 12-ply
    - Type: Pneumatic
  - Steering wheel:
    - Make: Firestone
    - Model: 7.50 x 15, 10-ply
    - Type: Pneumatic
- Transmission:
  - Make: Warner
  - Model: T9–L2
  - Type: Spur-gear, selective-sliding, four-speed
- Voltage regulator:
  - Make: RBM
  - Model: VR–401
  - Type: 3-unit
- Wheels:
  - Drive:
    - Make: Hughes-Keenan
    - Model: 10418
    - Type: Solid
  - Steering:
    - Make: Budd
    - Model: 37610–D3
    - Type: Steel

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